CIVIL ENGINEERING

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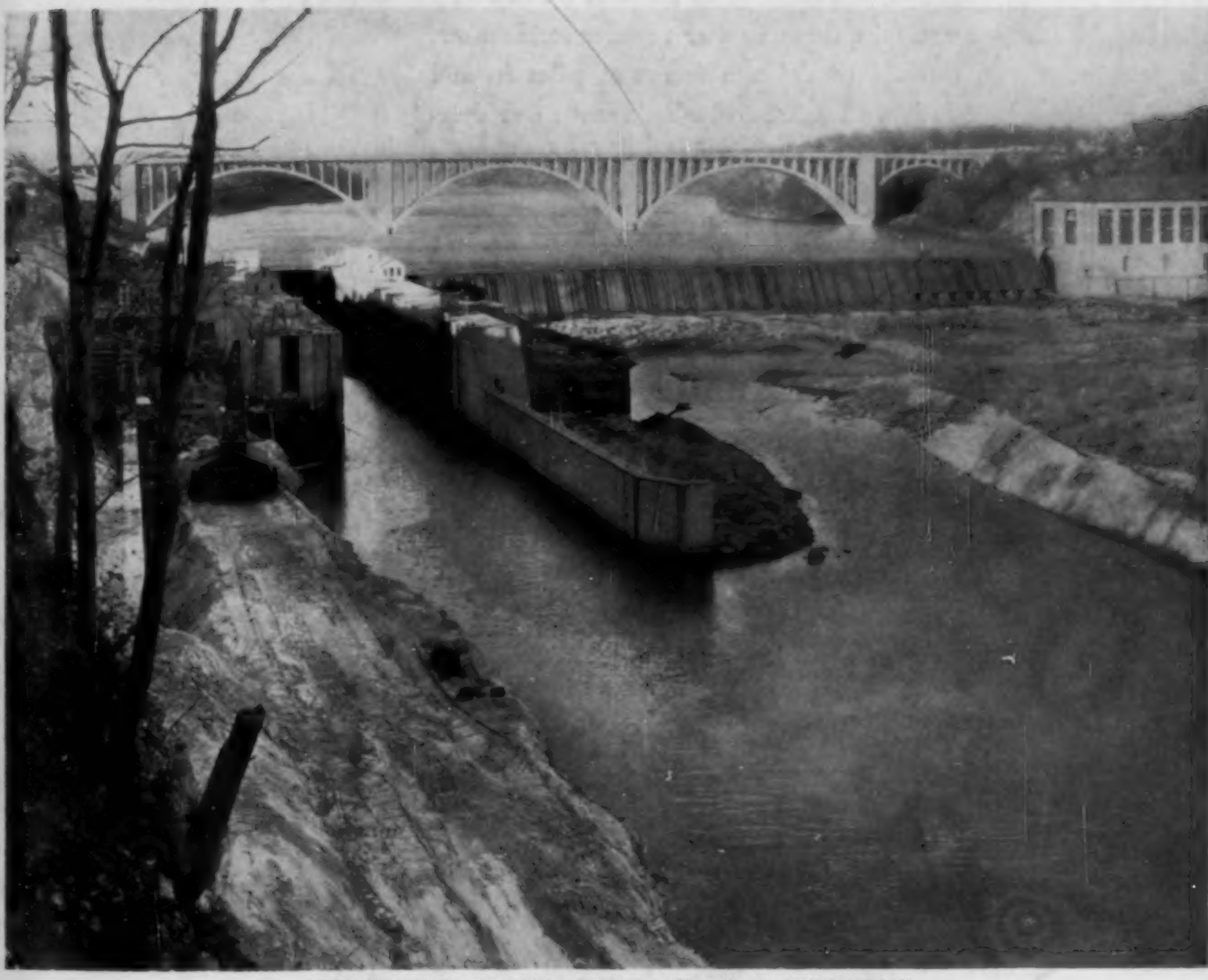

TWIN CITY LOCK AND DAM—SECOND LOCK UNDER CONSTRUCTION

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

Volume 1 — Number 15

DECEMBER 1931

A Patent of Nobility Conferred

President Roosevelt's Address to the Employees

of the Isthmian Canal Commission

Gentlemen:

All that I would say is how heartily I appreciate on behalf of the country the work that you are doing. Yesterday and today, as I have been going along the canal and seeing the work, I have had more and more a feeling toward you gentlemen and toward all connected with the canal, that they are earning a right to the gratitude of the country such as can normally be earned only by soldiers who have served in the few great wars of history. . . .

Next to man's home life, the thing best worth doing is what counts not only for himself but for the country at large, and that is the kind of thing you are doing. . . . I hope that the spirit already here will grow even greater so that it will make each man identify himself with this work and do it in such shape that in the future it will only be necessary to say of any man, "He was connected with the digging of the Panama Canal," to confer the patent of nobility upon that man.

In other words, just as we think of those who fought valiantly in the Civil War, so we feel that this man does not have to explain his part in the work of civilization. . . . What he has done explains itself. . . . We will have the right to say, "That man did his full duty, because he was connected honorably and in good faith with the greatest feat of the kind ever performed in America, the greatest feat ever performed by any nation in the history of the world."

Now good-by and good luck. You seem a straight-out set of Americans and I am mighty proud of you.

Theodore Roosevelt

This interesting address, which was given November 16, 1906, at Culebra, C.Z., during canal construction, was recorded by Arthur R. Richards, M. Am. Soc. C.E., then in the Canal Service. His transcript of the address and the signature affixed to it by President Roosevelt at the time are now in the possession of the Society. President Roosevelt would have been 73 years old on October 27 last.

Among Our Writers

George H. Herrold, was educated at Leland Stanford Jr. University and began his career in the West. For the past 20 years he has been active in solving St. Paul's engineering problems.

William N. Carey had field charge of river and harbor construction for the St. Paul District Engineer. He fought with the Engineers in France, came back to St. Paul a major, and for the past seven years has been Assistant City Engineer and City Engineer there.

J. A. Childs graduated from the University of Minnesota in 1909. For years he was Sanitary Engineer for the Minnesota Department of Health.

Francis Lee Stuart, President of the Society, is a railroad man, having been Chief Engineer of the Erie and the Baltimore and Ohio railroads. He now maintains consulting offices in New York, specializing in railroads and port development.

W. L. Darling has followed railroad construction in the Northwest since 1878. He was successively Chief Engineer of the Union Pacific, the Burlington, the Rock Island, and the Northern Pacific railroads.

Russell H. Bennett has been a principal in the development of numerous mines in North and Central America.

E. W. Davis taught three years in the School of Mines at the University of Minnesota. He has patented a number of improvements for ore dressing machinery.

Hibbert M. Hill taught hydraulic engineering at the University of Minnesota for four years before taking part in the recent investigations of the Upper Mississippi River for the War Department.

Lenvik Ylvisaker was engaged in design and construction work in connection with canalization of the lower Ohio River before he took charge of the Upper Mississippi River project.

Frederick H. McDonald's firm has dealt with organization, financing, use, and development of various industrial and utility projects in the South.

J. F. Coleman got his first taste of engineering on the survey of the Ferrocarril del Norte de Guatemala in 1884–1885. His wide consulting experience has been largely concerned with flood control and allied problems of the lower Mississippi Valley.

Robert Kingery practiced landscape engineering for six years after graduation from Wabash College. He then took up highway engineering and regional planning, in which he has had 15 years of experience.

Milton P. Adams graduated from the University of Michigan in 1918 to enter the World War in the Corps of Engineers. For 11 years he served the City of Grand Rapids developing its sanitary program.

C. R. Velzy had responsible charge on new designs of sewage treatment work for Oklahoma City and Grand Rapids, and also designed part of New York's Wards Island Plant.

O. L. Kipp has confined his practice to highway engineering for the past 20 years. All state and Federal aid road construction in Minnesota is supervised by him.

C. M. Babcock has had a prominent place in the development of Minnesota's highway system. He is a former president of the American Association of State Highway Officials and of the American Road Builders Association.

J. S. Dodds, who formerly taught highway engineering, is now Associate Professor of Civil Engineering in charge of surveying and city planning at Iowa State College.

William E. Stanley taught hydraulics at Purdue University for four years, was a captain of engineers in France, and since has been with Pearse, Greeley, and Hansen, of Chicago.

James W. Armstrong is a specialist in water filtration. For the past 20 years he has had a prominent part in the solution of Baltimore's water supply problems.

George J. Schroepfer upon graduation from the University of Minnesota in 1928 accepted his present position with the Metropolitan Drainage Commission of the Twin Cities.

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Volume 1 December 1931 Number 15

St. Paul Plans for the Future

A Fifteen-Million-Dollar Program Approved by Voters

LOCATED at the head of navigation on the Mississippi River, St. Paul grew rapidly, even before it became the capital of Minnesota in 1872. This rapid growth without any adequate city plan, and the rivalry between owners of adjacent plats, were responsible for conditions which later led to the creation of several bodies organized to outline and further the adoption of correlated municipal improvement projects.

In the three articles which follow, abstracts of papers presented at the St. Paul Meeting of the Society, the city's problems in matters of planning and sanitation are dealt with. The article by Mr. Herrold, originally delivered before the City Planning Division on October 9, shows how St. Paul's early growing pains were responsible for many of its later problems, and describes especially the work accomplished by the Planning Board created in 1918. Then Mr. Carey takes up the theme and, in a paper read before the Technical Session on October 7, shows how the city's Five-Year Program came to be adopted, and the various construction projects included in this plan, for which a $15,000,000 bond issue was voted. Finally, in a paper delivered before the Sanitary Division on October 8, Mr. Childs explains the sanitation problems which face the Twin Cities, and the progress which has thus far been made in finding a satisfactory solution.

The Necessity for Coordinated Planning

By George H. Herrold

Member American Society of Civil Engineers
Managing Director and Engineer, The City Planning Board, St. Paul

THAT St. Paul early recognized the handicap imposed by its narrow, circuitous, and jogged streets is evidenced by numberless newspaper articles urging the correction of these conditions. But the first organized attempt at winning public understanding and support of long-term planning was made in 1913, when a City Planning Conference was organized, composed of representatives from various civic clubs. This conference failed from lack of leadership.

Then, in 1918, the Planning Board was created by a city ordinance. It consisted of 15 citizens and 11 officials. The citizen members, who were appointed in 1919, made a careful survey to determine what appropriations would be necessary for the work of the board, and the city budget for 1920 included $25,000 for that purpose, with a promise of $25,000 for 1921, which promise was fulfilled. In 1920 I was drafted from the Engineering Department of the city and assigned by the City Council to the board, as Managing Director and Engineer.

Historical Background

Historical considerations are so important in replanning an old city that it seems necessary first to present the situation which faced the Planning Board in 1920. In 1849, when St. Paul was recognized as a municipal unit by legislative act, it had an area of about one third of a square mile. It became the territorial capital in 1851 and the state capital in 1872. In those days it was a river trading post where dog sleds from Hudson Bay and ox carts from Pembina and the Red River of the North exchanged their commodities with steamboats from the South. Life had many difficulties and the land was hard to tame. The filling of muskeg swamps or ravines was a slow process, for the earth had to be moved by oxen. Streets were made narrow and grading was crude.

Business houses clustered around the levee, which was the principal point of interest. In 1850 a total of 102 river boats landed at the levee, some of them carrying as many as 500 passengers. The population of the city increased from 1,000 in 1850 to 11,000 in 1860. During the same decade the population of the state increased from about 6,000 to 172,000. St. Paul, at the head of navigation on the Mississippi River, was the gateway to the Northwest.

On June 28, 1862, the first train in the Northwest ran from St. Paul to St. Anthony over ten miles of track, now a part of the Great Northern Railway system. During the subsequent years, 9 railroad companies built 23 lines into St. Paul, each selecting the best location and easiest grades, but all uniting in one passenger terminal at the levee.

Third Street, parallel to the river, became an important

business mart, and its narrowness (44.5 ft.) was a source of concern. In 1872 a new line was established for the street by the removal of all the porches, those architectural adornments of pioneer business houses. This gave the street a variable width ranging from 52 to 57 ft.

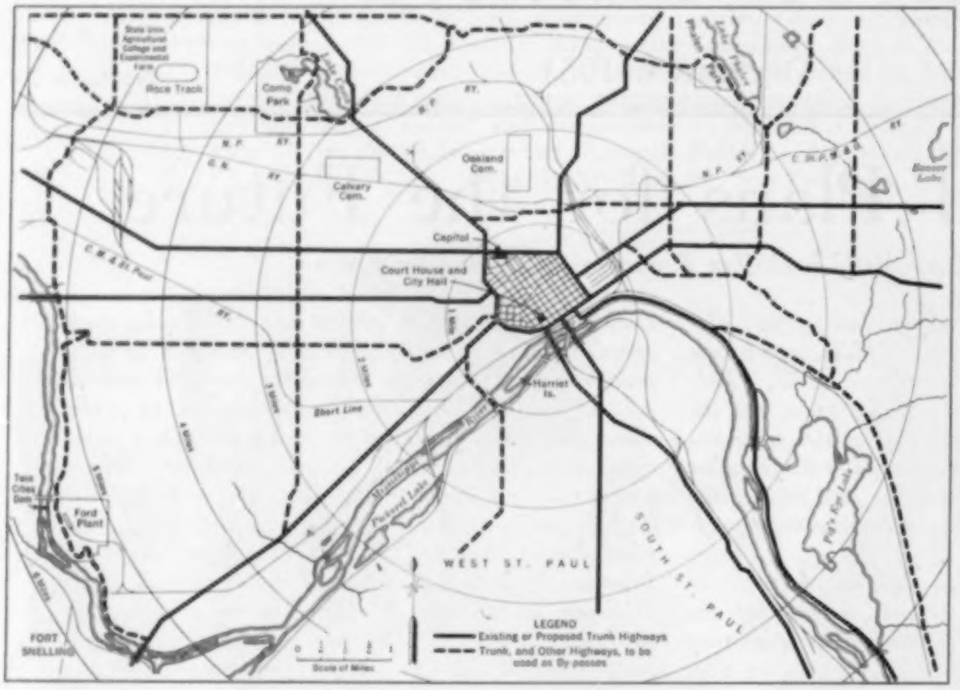


FIG. 1. THE CITY OF ST. PAUL
Proposed Layout for State Trunk Highways and By-Passes

For rival and scattered residential areas local improvements were carried out to make them accessible to the business center. Little thought was given to grades or directness. Temporary bridges were constructed at the easiest or least costly locations. These temporary bridges became permanent bridges, and the permanent structures fixed the transportation groundwork of the city. When additions were laid out, little attempt was made to match the streets of one addition to those of another. In some cases, streets were deliberately jogged to make the adjoining plat less accessible. Because of the rough and rugged topography, stairways were built to connect one level of land with another. At one time there were 88 public stairways maintained to make property accessible.

Prior to 1914 the city had a Park Board, a group of far-sighted men. In the course of about forty years this board acquired Como Park, totaling 427 acres; Summit Avenue Parkway, 3 miles long, totaling 67 acres; Phalen Park and lake, which now totals 486 acres; an addition of 77 acres to the system known as Indian Mounds Park; Wheelock Parkway, 4 miles long, including 68 acres; Harriet Island, 39 acres; and Edgcumbe Road, 120 ft. wide, which skirted the bluff for 4 miles in the southwestern part of the city. Between 1900 and 1905 a total of 177 acres were acquired along the Mississippi River extending for a distance of $5^1/_2$ miles. Prior to this, and as early as 1886, the city acquired by condemnation several miles of levee 200 ft. wide.

In 1893, the state legislature authorized the construction of a new capitol building. The site was selected by a commission—about 8 acres on a sightly promontory one hundred feet above the business district. In 1903, as the building neared completion, the architect, Cass Gilbert, prepared an ideal plan for the ground approaches and grouping of future buildings. Rigorous economies became necessary, and although 16 acres were added to the original 8 acres, the conception is far from being completely carried out.

In 1887 the present city limits were established, enclosing 55 sq. miles. During the years from 1885 to 1888, inclusive, 562 additional plats, totaling 26,000 lots, were recorded. There was no control of platting; individual impulse and section lines were the only guide. Through the years the street system in each addition has been connected, but the city is just beginning to recover from the surplus of lots, the result of mass production in 1887.

A rectangular street system prevails in St. Paul. Most of the residence blocks are 600 by 300 ft., bounded by 60-ft. streets. In the central business district the blocks vary from 300 to 370 ft. in length and are 300 ft. wide. Streets on the first plateau were laid out parallel to the river, and on the second plateau, 100 ft. higher, they followed the section lines. Continuity of downtown streets and residence streets is rare.

Oakland Avenue is one redeeming piece of engineering. Supported by a retaining wall and a parked slope, it sustains a 3 per cent grade for 2,200 ft. Another fine street laid out in the early days is University Avenue, six miles long, 120 ft. wide for five miles, and 80 ft. wide for one mile. It extends one mile in Minneapolis, to the University of Minnesota, and ends in St. Paul at the state capitol.

As the residential area of St. Paul spread out around the business district, it was the practice as soon as a few homes were built in a block to follow this development with a corner grocery, saloon, livery stable, or other use not in harmony with a residence district. This practice went on for many years with the result that when the zoning law went into effect in 1922 there were about 22,000 vacant lots within three miles of the Court House.

As street car lines were extended and new residential districts were established, many of the lots were sold with deed restrictions, the speculators, or "developers" as they were called, retaining ownership in the corner lots, on which they expected to erect apartment buildings. All these owners of corner lots were later found at the council table protesting against a zoning plan.

From retracement surveys made in 1887 the Department of Public Works had excellent engineering data at hand. Maps had been made on a scale of 100 ft. = 1 in., a half section to a sheet, with all measurements, ties,

angles, and monuments shown. All streets on the city map have center-line profiles, drawn to a uniform scale of 80 ft. horizontal, and 12 ft. vertical, to 1 in. All sewers are shown on separate profiles to the same scale, with elevations of inverts at grade points. The city assessor's map shows front foot values of all property. In 1891 the Mississippi River Commission determined the elevation of the city base bench mark at 694.8 Biloxi datum and completed a triangulation system and topographic map of the city, published on a scale of 1,600 ft. = 1 in.

It was a simple matter from these data for the board to make a cadastral map of the city, such a map being essential for city planning. A base map of 1,200 ft. to 1 in. was used for all survey data. This scale was chosen because it made a sheet easy to handle, 32 by 46 in. The topographic map was then carefully photographed up to this scale.

The work undertaken by the Planning Board in 1920 may be outlined as follows: to replan an old city, that is, to find a way to coordinate existing constructions and uses and mould them into a comprehensive plan; to round out and revise a well planned park and boulevard system of the older type; to harmonize existing plans for the state capitol grounds and approaches with a plan for a city and county civic center; to create a thoroughfare plan connecting the downtown district with state trunk highways and outlying residence districts; to bring about cooperation between the Department of Parks and the Department of Education in the matter of playgrounds—to endeavor to make one site serve both purposes, and to avoid the duplication of land purchases; to improve the street system in the downtown district for both pedestrians and vehicles; to improve the transit system, which was excellent in serving the residential districts but inefficient and impractical in its routing through the business section; to determine what grade separations with existing railroads were vitally essential; to prepare a zoning plan; and, as provided in the ordinance creating the board, to "keep informed of the plans of the various departments of the city, all public service corporations and other official and unofficial organizations, and actively endeavor to coordinate such plans and safeguard and direct the city's physical development."

In developing a plan, the board recognized the political character of St. Paul, as the fifth largest state capital in the United States in point of population. The Federal Government is also represented in it by some 12 departments. As a result, large numbers of those traveling to and from the city by train, bus, automobile, electric railway, and airplane have business with some governmental department. Their commercial interests are incidental.

The board appreciated the fact that a plan which would be adequate for future needs would appear too large for the present and probably call forth the ridicule of the average citizen. On the other hand, a plan made for present needs only would be inadequate for the future and would cause the board to be condemned for short-sightedness. It realized that a successful plan would be one that would meet present needs but which could be progressively developed, expanded, and extended as the wealth and culture of the city increased; that its work was to lay down certain principles as a basis and then make city planning an everyday matter. The board did not attempt to do over everything that had already been done, but recognized that others had given serious thought to the city's needs. This method was followed as long as it did not interfere with a logical program. Late in 1922 the findings of the board were published in book form as the *Plan of St. Paul*.

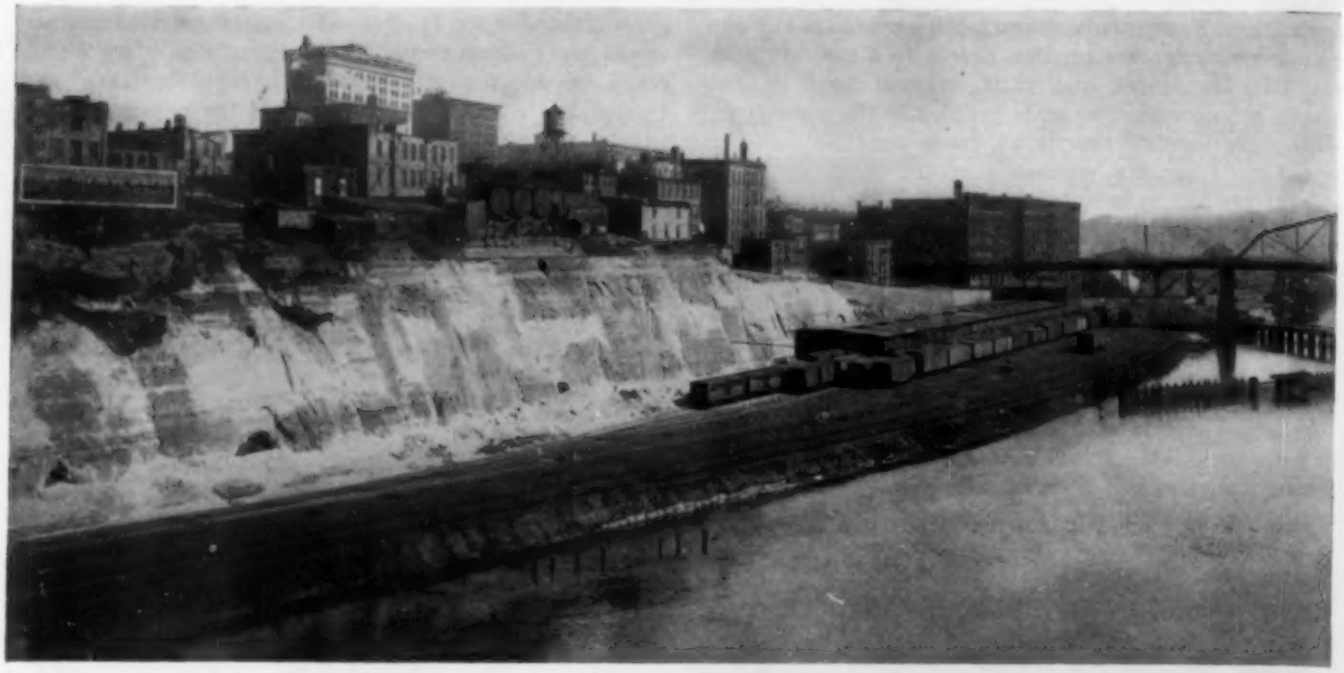
Capitol Boulevard
Cass Gilbert's Plan for Grouping of Buildings Around the Minnesota State Capitol

Traffic Problem Complex

The traffic problem required much study. In 1910 there were 1,100 motor vehicles in the city. In 1920, a cordon count showed 55,000 vehicles entering and leaving the business district in 12 hours, with no change in the street capacity. An analysis of St. Paul's traffic problem was made, and among the principal causes of street congestion were found to be the following:

Too many street intersections; parking of vehicles on business streets; double-track car lines on narrow streets; small business blocks creating many corners and much turning at those corners; mixing of trucks, buses, street cars, automobiles, and horse-drawn vehicles on all streets; permitting left-hand turning at busy intersections; almost square corners in the curb line at intersections; through traffic using business streets; inadequate thoroughfares leading to the central business district; many trucks delivering to individual business houses; lack of police control; non-uniformity of traffic laws with those of other Minnesota cities and of other states; and railroad grade crossings. Some of these causes of congestion must be accepted as unavoidable; others can be cured and are being eliminated at the present time.

The board did not find the information to be had on desirable street widths of great value. We did not find that a major street, per se, should be 120 ft. wide or a minor street 60 ft. wide. It would seem that for industrial streets, mercantile streets, and arterial roads the 56-ft. roadway, or six-lane road, has proved itself to be most efficient; and that for residence streets the 26-ft. or 36-ft. roadway is ample. Sidewalks are a separate and distinct consideration. They must be designed to



The River Front from Wabasha Street to Robert Street

Top: In 1925 Before the Robert Street Truss Was Replaced by a Concrete Bridge

Lower Left: In 1931—Third Street Esplanade Development, Indicating Sites of Court House and New Federal Building

Lower Right: Water Front Development Now Under Way: (A) City Hall and Court House (Steelwork Completed); (B) Third Street Esplanade (Arcaded Second Street Completed); (C) the First National Bank Building (Entirely Enclosed); (D) New Federal Building (Old Buildings Demolished and Contracts Being Let for Foundations); (E) State Office Building (Buildings Demolished and Contracts Being Awarded for Foundations)

coordinate with the floor area of abutting buildings, just as the areas of corridors and lobbies in buildings and aisles in theaters are determined by the number of people who will use them.

The street cross section which had been adopted was 10 ft. for walks and 40 ft. for roadway. The usual and most satisfactory cross section is a 12-ft. walk and a 36-ft. roadway. Sidewalk space is a fundamental need in St. Paul, and to increase this space it was recommended that arcades be created either along the frontage of the street or on the plan of a maltese cross through the center of the blocks. At the present time there are 2,185 lin. ft. of arcades or private sidewalks running through buildings in the retail district. A number of these arcades are the result of persistent city planning propaganda.

Our campaign for wider sidewalks has been met with the argument that people no longer walk, and that roadway space is what is required. This would not seem to be true. The filling station and garage are the only business places that can be entered with an auto; all other commercial houses are entered on foot. The "window shopper" should also be considered.

To improve the street layout downtown, a gridiron plan was laid out with a view to increasing the percentage of street area, which at that time was only 29 per cent. It was thought to raise it if possible to about 35 per cent, and also expand the intersections by corner cut-backs, as exemplified by the Northern States Power Company's building at Fifth and Wabasha streets. This cut was made voluntarily on request of the Planning Board. When the five-year program is completed in 1933 there will have been widened, opened, or extended 18.8 miles of streets since 1921. Of these, $7^1/_4$ miles are under the five-year program. The transit plan provides for consolidating movements of street cars on certain streets to make other streets available wholly for automobile traffic.

In carrying out the program of improvements, the

principle of assessing benefits was recognized. This principle has been followed consistently. While the carrying on of public improvements during a depression is an excellent thing, it must be remembered that it is more difficult to prove benefits at such a time than it is during inflation. Also, mercantile streets when widened may be assessed heavily, but no benefits can be shown to come from the widening of a street zoned for residences.

It was early determined that the state buildings should form one group and the city, county, and Federal buildings another; and that the last-mentioned buildings were best arranged along our river front. We now have a coordinated plan in which the river front development, the Third Street Esplanade, connects with the capital approach at Seven Corners Round Point. Along this esplanade are the following structures either completed or under way: the Union Depot, the U.S. Customs and Post Office Building, the Robert Street Public Information Building, the City Hall and Court House, the Women's City Club, the Hill Reference Library, the St. Paul Public Library, the Minnesota Club, and the New Auditorium.

For the state civic center group we have the Capitol Building facing south, the State Historical Society Building, finished in 1915, lying southeasterly and facing west, and the $1,400,000 office building, to be built on a site to the southwest of the Capitol Building. It required a year of hard work on the part of the board and the St. Paul Association of Commerce to bring about the obvious location of the state office building. It involved statewide publicity, resulting in the Building Commission's relinquishing its right to select the site and submitting the question to the legislature, which, by a vote of 170 to 6, approved this site. The war is over, the axis of the capitol is established together with the nucleus of a fine group of state buildings.

The board has been instrumental in two very meritorious park acquirements—Highland Park of 244 acres, and Battle Creek Park of 60 acres. Highland Park cost $425,762 for the land and buildings. This cost was assessed over a benefited district of 4,300 acres. The assessor's true value of the benefited area was $67,000,000, making the cost of the park only two thirds of one per cent of the value of the district assessed.

The zoning ordinance is a vital part of the city plan. It was prepared concurrently with the plan, and became a law in August 1922. After nine years of zoning, St. Paul has materially improved the residential environment. We have no height limitations in the central business district; that has been left wholly to economic phases, but height limitations have been established in all other parts of the city. Around the state capitol there is a 40-ft. limitation in the rear of the building and a 75-ft. limitation on the lower land in front.

Platting is now controlled by the requirements of zoning, that is, no plats are accepted that do not fulfill the area requirements of the zoning ordinance. Platting is also controlled by the thoroughfare plan as to layout. In residential districts we are accepting long blocks from 880 to 1,320 ft. long. They reduce the number of intersections and make for safety. The pedestrian is provided for in these long blocks by a public walk through the center of the block.

While each year showed some part of the board's plan carried out, it was not until 1926 that a definite long-term program was prepared and submitted to the Charter Commission. It involved an expenditure of $10,000,000, a part of which would be assessed to benefited property. As a means of financing these projects it provided for a three-mill tax, which would produce about $520,000 per year. It was a "pay as you go" plan. The board was unable to induce the Charter Commission to submit it to the people.

FIVE-YEAR PROGRAM FINALLY ADOPTED

In 1927, through the influence of the newspapers, which recognized the need of a selling agency, the United Improvement Council was organized, consisting of representatives of various civic organizations. They worked out a five-year financial program for city planning projects, based on a bond issue. This $15,000,000 program was referred to the people in 1928 and carried by a very large vote. It is this program of construction that is now being carried out in the city.

Taking into consideration the population and wealth of this city, we believe that it presents a valid claim to preeminence in constructive city planning. Behind it all is the plan of 1922, carefully worked out in its engineering details. It guides the multitude of separate impulses of citizens and city government, and is a splendid example of the value of a master plan, when backed by a group of public-spirited citizens.

Five-Year Construction Program Adopted

By William N. Carey

Member American Society of Civil Engineers
Chief Engineer, Department of Public Works, St. Paul

A STATEMENT of the improvements being made or about to be made in any city is of little general interest to engineers, for such developments usually vary only in amount and in details of design and construction. St. Paul is proud of her extensive street widening projects, her $4,000,000 City Hall and Court House now under construction, her airport, and other public works of local importance. Yet these improvements present nothing new or especially worthy of comment. The manner in which they were planned, however, is unusual and should be of interest to every American taxpayer.

In the fall of 1927, there were submitted to a vote of the people of St. Paul a number of proposed bond issues for various needed local public improvements. These bond issues did not differ in character from those which had

been approved previously in St. Paul and in many other cities and which are still being approved elsewhere at every election. In general, they were recognized as meritorious in and of themselves, but they were defeated by a large majority of the voters. Disapproval was based on the argument that the projects covered were not correlated, were not based upon a comprehensive study of the needs of the city, and did not form part of a proper civic improvement program. In advocating defeat of the 1927 bond issues, the St. Paul Association of Commerce, the local organization of business groups, promised that it would take the lead in making a study of the needs of the city and would submit a report to the public advocating a proper and logical improvement plan.

MUNICIPAL AIRPORT UNDER CONSTRUCTION
$1,000,000 Invested in Lands; 2,000,000 Cu. Yd. of Hydraulic Fill

UNITED IMPROVEMENT COUNCIL FORMED

In fulfillment of that promise an organization known as the United Improvement Council was formed and, in August 1928, the promised report was published. The United Improvement Council, which will be referred to subsequently as the council, was composed of delegates, serving without pay, from 25 civic organizations. The following list of these organizations is given to indicate the make-up of the council, although some of the names have only a local meaning:

All St. Paul Council	Real Estate Board
Bureau of Municipal Research	St. Paul Association
City Council	Trades and Labor Assembly
Civic Union	Women's Greater St. Paul Committee
County Commissioners	Engineers Society of St. Paul
Fourth District Federation of Women's Clubs	American Legion
Gavel Club	Builders' Exchange
Greater St. Paul Committee	Sterling Club
Junior Pioneers	Business and Professional Women's Club
League of Women Voters	Teachers' Federation
Parent-Teachers Association	St. Paul Chapter, American Institute of Architects
Planning Board	Women's Welfare League
	Midway Club

Delegates were divided into several groups, each group devoting its time to the study of some particular phase of the needs of the city. A general steering committee, or board of directors, was elected by the delegates from among themselves. To this group fell the labor of correlating the work of the various subcommittees. A careful analysis was made of the financial condition of the city and county, and of the manner in which bond issues in varying totals could be paid off by the people without their assuming an excessive tax burden.

At St. Paul, the city and county are one for all practical purposes since the city limits almost coincide with those of Ramsey County. This peculiar geographical condition makes easy the close cooperation of our city and county governments, and it facilitates the financing of strictly city projects through county bond issues, a procedure entirely justifiable as about 95 per cent of the funds of the county come from the pockets of St. Paul taxpayers. In the program the county was used as one financing agency, and the city as the other. The needs of the city were studied by the various committees, which roughly estimated the cost of each improvement proposed and made some recommendations as to financing.

IMMEDIATE NEEDS DETERMINED

City projects estimated to cost about $45,000,000 were found to be desirable, but this sum was more than could be provided. The board of directors then concentrated the council's study on the projects which seemed in greatest need of immediate attention.

THIRD STREET AS WIDENED
When Completed, This Project Will Be About Three Miles Long and Will Cost About $2,000,000

From the work of its committees extending over a period of nearly a year, the council developed its report, recommending bond issues to the amount of $15,000,000 for improvements to be made over a five-year period. The proposal, as submitted by the council, was in turn referred in proper form to the voters in the fall election

of 1928, and was approved by a large majority. The council stated in its report that, in formulating the recommended program, it was guided by the general principles here quoted:

"The public improvements of the city and county during the next five years should not be piecemeal, patchwork, haphazard, or merely time-serving in character; but each improvement should be a part of a definite program which, when completed, will take care of the needs of the city and county during the next five years in a permanent manner, adequate not merely for the present but for the future, to the end that wasteful expenditures may be avoided and that the city and county, once these needs are met, may forget them and turn their attention to other activities with the feeling that as to the matters covered by this report, they are in a position to hold their own among the most vigorous and progressive competitors. We cannot emphasize too strongly that present needs must be met in a manner adequate for the future as well as the present, and that, where a need is permanent, the expenditure of money to take care of the matter in a temporary way is generally wasteful. Nor can we likewise emphasize too strongly the need of providing those in charge of the program with the assurances that the necessary funds will be forthcoming when and as needed to carry forward the work. Too often, city and county officials have been unable to plan more than a year ahead with any assurance that funds would be available when and as needed to complete the program, resulting in temporary, makeshift, unrelated improvements, and the taking care of the particular project that seemed for the moment supported by the loudest clamor."

PART OF THE SEVENTH, EIGHTH, AND NINTH STREET WIDENING PROJECT

To Provide an East and West Traffic Artery, at a Cost of About $4,600,000

The report enunciated a belief by the council that in the adoption and prosecution of its program "the city and county will have met their needs for the next five years in a manner that will stir the pride of every citizen not merely in the physical structures themselves but in that which comes of worthwhile accomplishments."

ADVANTAGES OF THE FIVE-YEAR PROGRAM

The projects finally included in the $15,000,000 program covered new schools, parks, and playgrounds; a major addition to the Municipal Auditorium; a new City Hall and Court House Building; several other secondary buildings for city departments; improvement

THIRD STREET VIADUCT

Three Quarters of a Mile Long, Spanning 40 Railroad Tracks and Costing $850,000

of the municipal airport; and $6,000,000 worth of street improvements. Most of the projects which the council was forced to exclude from the present program probably will receive favorable consideration upon the completion of the present five-year schedule. The council held the present expenditure definitely within the credit limitations of the city and county and within the expected ability of the taxpayers to meet when due.

The belief of the council, "that the certainty of a definite program followed by actual . . . prosecution of the work will stimulate the confidence, energies, and activities of our citizens, and influence materially the private development of our city," has been proved correct. Private activities unquestionably have been stimulated through the influence of the definite, five-year improvement program. So far the heavy hand of nation-wide depression has rested lightly on St. Paul. At present, the St. Paul Association is giving wide publicity to a short tour of the city including improvements both public and private which are under construction or just completed, the total cost of which is $50,000,000.

Our unemployment problem today does not compare with that in other cities of the same size or larger. Under date of November 19, 1930, the *New York Times* carried a news story headed, "Program Made in 1928 Helps St. Paul's Idle," with a subhead, "Plans for $16,000,000 of Public Works Might Have Been Laid with Today in View." Under date of January 10, 1931, *Colliers' Weekly* printed a full-page editorial headed "According to St. Paul." Of particular interest is the following excerpt from this editorial:

"Minnesota's capital city is a conservative place and, compared with the most populous settlements, it is relatively small.

"For all that, St. Paul in its own way is setting a pace which larger and richer cities might profitably follow. The secret is just brains. The leaders of that city have been doing some good hard thinking and the people are backing up their thought.

"Spectacular as it is, now that it is well under way, the St. Paul plan is essentially simple. About three years

ago a group of influential men began to think about the needs of their city as a whole. Before that, each had been devoted to his own special interest without caring much how what he did affected the entire community. This little shift in attention and emphasis has had revolutionary results

"To the amazement of nearly everybody, it was found that a vast program of building could be accomplished without increasing taxes, if only necessary, permanent improvements were undertaken.

"The program was submitted to the voters and approved by a staggering majority. Now St. Paul is half through the first five years' work. Broad highways have been cut through the city. Schools and streets have been located with a view to protecting children from the hazards of automobiles and trains. What has already been achieved has caught the imagination of the people. The taxi driver in the street speaks with pride of what his city is accomplishing.

"Among the fortunate consequences is the effect this program has had in combating unemployment. St. Paul seems relatively to be better off than most other cities. Not many, however, take the broad view and the long look which these citizens of St. Paul have directed at the upbuilding of their community. The usual procedure is to divide the funds for political consideration. The St. Paul plan can be extended to other cities, to states, and to the nation. It is as fundamental as thought."

OTHER CITIES SHOULD FOLLOW SUIT

There has been much favorable press comment from outside St. Paul about our five-year program. The comment cited is sufficient to show the attitude of the press in general toward St. Paul's effort in the direction of better civic planning and building. The St. Paul plan for inaugurating, financing, and executing extensive public improvements, as *Colliers'* suggests, might well be adopted by other cities. It provides one effective way in which the leading business men of any city can combine their forces and in a large measure remove from politics the allocation and expenditure of public funds for public improvements. Looking at the situation in October 1931, we can state without question that the plan adopted in August 1928 has been a splendid success. The success of this first five-year program means that, upon its completion, another five-year program probably will be adopted, and the systematic planning and financing of public improvements will become a permanent principle in St. Paul.

Sewage Disposal Problems of the Twin Cities

By J. A. CHILDS

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IN order to understand the problem of sewage disposal now before the Twin Cities, a description of the Mississippi River in the stretch affected is essential. The Mississippi rises in northern Minnesota and flows in a southerly direction a distance of nearly 2,500 miles to the Gulf of Mexico. The drainage area of the river above the confluence with the Minnesota River at the Twin Cities is approximately 19,000 sq. miles, and that of the Minnesota about 16,000.

The area drained by the upper Mississippi includes numerous lakes, some of which are utilized as reservoirs for the storage of water during seasons of plentiful rainfall, to be released during periods of drought. The combined effect of this lake and reservoir system makes possible a greater flow in the Mississippi during periods of dry weather than in the Minnesota, the watershed of which, though nearly as large, contains comparatively few lakes. This, together with the fact that a considerable portion of the drainage area of the Minnesota is located in a region of lower rainfall than that of the upper Mississippi, results in a great difference in the discharge of the two rivers during seasons of low water. Frequently the discharge of the Mississippi at its confluence with the Minnesota is approximately 7 to 10 times that of the Minnesota, particularly during low-water periods of both summer and winter. As a result, the dilution afforded by the Minnesota is of comparatively little value during the periods of the year when such dilution is most needed to care for pollution.

MISSISSIPPI RIVER AT ST. PAUL
Part of the Pool Created by the Hastings Dam

For many years the Mississippi has been receiving the untreated sewage and industrial wastes from

Minneapolis and St. Paul and the smaller adjacent municipalities, including South St. Paul and Newport, where large packing industries are situated. Exclusive of the Fort Snelling Reservation, the metropolitan area of Minneapolis and St. Paul contains nearly 135,000 acres. The estimated population within this area in 1927 was about 775,000. There were in operation on January 1, 1928, about 1,125 miles of sewers, largely of the combined type, draining about 42,000 acres and serving a population of approximately 685,000. A total of about 100,000,000 gal. of sewage and packing house waste is being discharged daily directly into the river from the sewerage systems of this area. The combined effect of this domestic sewage and industrial waste is equivalent to the domestic sewage from a population of about 1,300,000, computed on the oxygen-demand basis.

Following the construction of the Twin City Lock and Dam in 1917 the effect of pollution became particularly noticeable. This dam is located between St. Paul and Minneapolis and has created a pool of relatively quiet water extending upstream about $4^1/_2$ miles. Prior to 1917, the sewage was swept away by the rapid current of the river so that its effect was not particularly noticeable in the vicinity of the Twin Cities. The Twin City Lock and Dam, by retarding the current, has so changed conditions that the section affected has been converted into what is virtually an open septic tank, in which sludge and silt are deposited, and on the surface of which sleek and floating sludge are frequently seen. Odors are sometimes noticed by residents along the river, by persons walking or riding along the parkways at the top of the bluffs, and by those crossing the bridges.

Another dam at Hastings below the Twin Cities creates a pool of relatively quiet water about 30 miles in length, extending upstream to the Twin City Lock and Dam. This pool receives about 75 per cent of the sewage from St. Paul, and all of the wastes from the meat packing plants at South St Paul and Newport.

Cognizant of this condition of pollution of the river, the Minnesota Legislature passed a law in 1927 creating the Metropolitan Drainage Commission for the purpose of studying the sewage disposal problem of the Twin City area. Since its organization, the commission has investigated the subject in detail and has published three reports. The conclusions of the Metropolitan Drainage Commission, as set forth in its report for the years 1929 and 1930, are as follows:

"(a) Minneapolis and St. Paul should unite to form a single district for the collection and disposal of their sewage, either with or without the inclusion of . . . other continuous municipalities.

"(b) A project . . . providing for treatment of all the sewage from Minneapolis and St. Paul in a single plant in the Pig's Eye Lake district, should be adopted for the reason that it offers many advantages over other projects and will be less expensive than the combined cost of independent systems for both cities.

"(c) With the information now available, a fair and equitable method of cost apportionment can be formulated which should be reasonably satisfactory to all the municipalities concerned, and

"(d) A serious state of pollution prevails in the Mississippi River at and for a considerable distance below the Twin Cities which endangers public health, creates a public nuisance, depreciates property values, menaces the health of live stock, destroys the recreational value of the river, and injures the fishing and clamming industry. This situation is steadily becoming more serious because of the increasing quantity of sewage and wastes discharged into the river from year to year. The realization that several years must elapse before construction of the relief works can be completed makes obvious the need of immediate action."

Nuisance Created by a Minneapolis Sewer Outlet

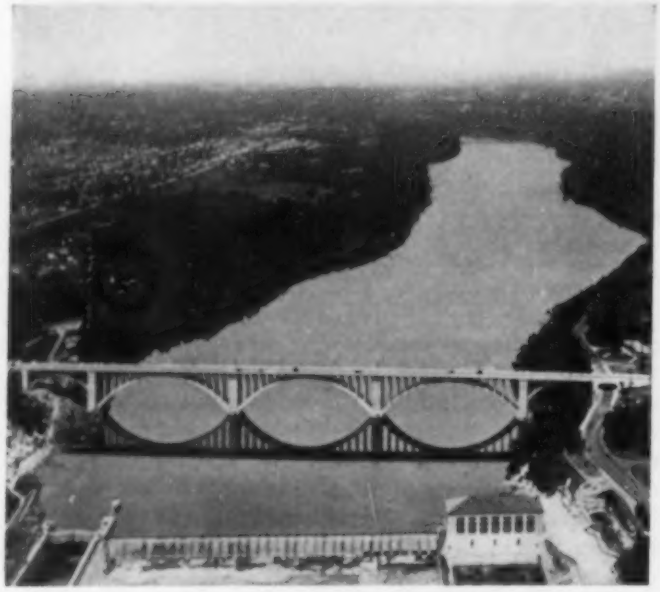
Bills designed to enable the cities to cope with the sewage problem were introduced at both the 1929 and 1931 sessions of the legislature. At the 1931 session a bill creating a metropolitan sanitary district embracing Minneapolis, St. Paul, South St. Paul, and adjacent areas passed both houses but was vetoed by the governor. Minneapolis strenuously opposed the passage of this bill, (S.F. 147) principally because the inclusion of South St. Paul and Newport, with their packing plants, in the district would make the total annual charges to Minneapolis in 1940 about $85,000 higher than those of an independent system for Minneapolis.

As a move toward settling the controversy, Governor Floyd B. Olson, on May 6, 1931, invited to his office for conference the mayors, representatives of the councils, city attorneys, and city engineers of Minneapolis, St. Paul, and South St. Paul. At the Governor's suggestion, the city engineers of Minneapolis and St. Paul gave further study to the problem and prepared a report for submission to their respective governing bodies. This report recommends that St. Paul and Minneapolis unite in the construction and operation of a sewage disposal system; that each city construct, operate, and maintain the works used exclusively by that city; that the construction cost of works used in common be paid for on an assessed valuation basis; and that the cost of operation and maintenance of the jointly used works be apportioned on a sewage volume basis.

Minneapolis, on June 8, 1931, by vote of the people adopted a charter amendment authorizing an annual tax levy of $2^1/_2$ mills, the proceeds to be used for "the construction within or without the city of connecting and intercepting sewers, sewage disposal plant, and other necessary works that may be required for the treatment, reduction, or disposal of sewage and industrial wastes, and for the acquisition of lands, easements, and site necessary therefor." This amendment authorizes Minneapolis to proceed with the construction of an independent

sewage disposal system. It does not, however, prevent Minneapolis from joining with St. Paul and other municipalities in the area in a combined system.

The State Board of Health invited the mayors and representatives of the city councils of Minneapolis and St. Paul to attend a special meeting of the board on August 17, 1931, for the purpose of initiating further negotiations. Accepting the board's invitation, both Minneapolis and St. Paul appointed committees including the mayors and members of each city council. These committees have held several joint meetings and so far have agreed upon the principal issues which have heretofore been controversial.



MISSISSIPPI RIVER ABOVE THE TWIN CITY LOCK AND DAM
This Park-Bordered Pool Receives All the Sewage from Minneapolis and About 25 Per cent of That from St. Paul

JOINT DISPOSAL PLANT—PROJECT I-8

Of the many projects which the commission has developed for the solution of this problem, the best and probably the most economical one considered up to the present time provides for the construction of a joint system whereby all the sewage of Minneapolis and St. Paul would be conveyed to a single treatment plant located at Pig's Eye Lake.

About forty miles of trunk and branch intercepting sewers costing about $10,340,000 would be required. The sewers would range in size from relatively small ones about 12 in. in diameter to the main trunk interceptor, the lower portion of which would be approximately $13^1/_2$ ft. in diameter. The Minneapolis sewage, together with that from the western section of St. Paul, which is now being discharged into the river in the pool created by the Twin City Lock and Dam, would be collected by a system of branch interceptors of tunnel construction located parallel to the river bluff. These interceptors would then discharge this sewage into the western end of the main or trunk interceptor. This trunk interceptor would be constructed by tunneling in the soft sandstone formation underlying the city. It would conduct the sewage in an easterly direction through St. Paul to Pig's Eye Lake, where would be located the sewage treatment plant, costing about $3,840,000 for works needed in 1940. Sewage from other portions of St. Paul would be brought to the trunk interceptor by other branch interceptors.

Although Project I-8 is primarily a Twin City project, the sewage and waste from South St. Paul and Newport might be treated at the Pig's Eye Lake plant. The only change required would be an increase in treatment plant capacity. There are a few low-lying areas, the sewage from which, comprising about 2 per cent of the total from Minneapolis and St. Paul, would require pumping for delivery to the interceptors.

Independent systems for Minneapolis and St. Paul have also been studied. In Table I are given the latest estimates, submitted to the commission on July 1, 1931, for the total annual charges of various independent and combined projects, and the savings in 1940 and 1970 by uniting the two cities in one system. All estimates are based upon treatment of sewage by the activated sludge process and for a degree of treatment sufficient for nuisance prevention, assuming that the packing plant wastes will receive proportionate treatment.

TABLE I. COST OF VARIOUS SEWAGE TREATMENT PROJECTS

SYSTEM	Total Annual Charges 1940	1970
Independent systems:		
Mineapolis (Project T)	$ 940,000	$1,445,000
St. Paul (Project Ts)	660,000	955,000
Total	$1,600,000	$2,400,000
Combined system (Project I-8)	1,455,000	2,175,000
Total savings by uniting	$ 145,000	$ 225,000

According to the methods of cost apportionment recommended in the report of the city engineers, the two cities would share in these savings approximately as follows:

CITY	1940	1970
Minneapolis	$ 40,000	$ 80,000
St. Paul	105,000	145,000

With all the costs, including construction and operation, apportioned on the basis of the assessed valuations of the two cities, the savings by uniting would be shared approximately in the following manner:

CITY	1940	1970
Minneapolis	$ 5,000	$ 45,000
St. Paul	140,000	180,000

Aside from the economic benefits accruing to both cities by uniting, it will be noted that Project I-8 provides for the conveying of the sewage of both cities to a plant at a site which is downstream from both the residential and business sections of St. Paul. Should each city install a separate and independent system, the nine-mile stretch of the river from the confluence of the Minnesota downstream to Pig's Eye Lake would carry the partially treated sewage from the Minneapolis treatment plant.

The stretch of the river through St. Paul is used to a considerable extent for boating. If all the Minneapolis sewage were treated with that from St. Paul in a single plant located below St. Paul at Pig's Eye Lake, the river through St. Paul would be, during the greater part of the time, practically as clean as it is upon entering Minneapolis, and both cities would derive equal benefits from the disposal system.

Engineers' Opportunities

By Francis Lee Stuart
President American Society of Civil Engineers
Consulting Engineer, New York

There can be no wealth without hard, unremitting work. The present economic depression, President Stuart believes, is not so much the result of overproduction as it is of insufficient production in the years following the war. Longer working hours and increased output will constitute an essential step in our progress toward prosperity. In the era of international cooperation and effort that must come, the engineer will be entrusted with tremendous and far-reaching responsibilities. With his clear thinking and vigorous action progress is possible. This paper was presented by President Stuart on October 7, 1931, before the Fall Meeting of the Society in St. Paul.

There exist today a great need and an unparalleled opportunity for engineers to use their powers of thinking and to make proper use of information and world trends for the benefit of mankind.

For what our civilization has given us, we owe to our profession and to our country a duty to be eager for public service and for greater usefulness, and we should, with resolute cooperation, take a serious part in the solution of the problems which beset us all.

The first requisite is that we, as individual members of our profession, engineers young and old, be more than scientists, more than inventors, more than designers, more than constructors. We must give the same quality of thought to matters of public progress and human interest that we give to technical matters and materials, and thus we shall make our technical judgment and advice more helpful.

I have always felt that, while technical and creative work is a major phase of the engineer's usefulness, it is not enough. In addition to contributing technical knowledge to help our prosperity, we should direct more of our individual energies toward taking our place with the forces which decide ways and means, and the uses to be made of our material progress; and by that I mean that we must cooperate with all other forces to see that the world's work is directed by clear thinking; that the ability to secure the mental and physical equipment to produce wealth does not destroy our wealth; and that the greatest use to be made of our material progress is to improve living conditions and standards; and to see that it is properly distributed for the happiness of all.

We, as engineers, should also do our share in solving the greatest problem of our age. This is to determine the direction in which living conditions shall be improved, and how the fruits of progress shall be stabilized and distributed in an equitable way to satisfy human wants as they are brought about.

NO WEALTH WITHOUT WORK

Wealth is the possession of things tangible and intangible that are needed for the moment; that are useful for the moment; or are mentally considered of value for the moment. Tangible wealth consists of such things as plants and buildings, factories, real estate, roads, railroads, cattle, even chickens and fences; and intangible wealth consists of good will, patents, managerial experience—all of earning capacity, and only as long as they have earning capacity are such things intangible wealth. All wealth comes from the country's cumulative surplus of income from useful work, over living expenses, or the consumption of revenue from or for various non-productive causes.

In the case of the United States, our ancestors had to work hard, very hard, to deny themselves, and save and save. Their wealth grew by leaps and bounds because living expenses were almost nil and non-revenue expenditures very limited. As they found the need they imported from abroad such things as they could not at the time produce cheaply or produce at all, and so added such of these things as were proper to their wealth. This process has gone on until the normal increase of our wealth just before the war is said by students of the subject to have been about five billion dollars per annum, or about 15 per cent of our income.

The World War, regardless of the apparent monetary advantage of some particular person or country or section of the globe, so disarranged and retarded general world progress that no nation or individual is exempt from the penalties the present generation has to pay.

There are insuperable difficulties in making an inventory of the world's wealth, and experts disagree very materially in their estimate of such efforts as are possible in their own countries, but it would appear a possible conclusion, from the effect of the war on world expenses, that they may have been as great as the income since the war. Whether measurable or not, the nations of the earth may even have been consuming some of the world's cumulative wealth saved before the war.

In the United States, because of our luxury-loving wastefulness and careless non-revenue expenditures, it may be that our consumption for expenses or other reasons was greater than the revenue received over a period of years, and this may have greatly aggravated the other cause of the depression at home. In any event we have spent too much of our wealth, and we should give this probability of such "cause and effect" serious thought, and at least reduce our non-revenue producing expenditures.

Consumption of the world's tangible wealth and credit, based on the world's cumulative wealth, caused inflation and made it easy to distribute money in favored sections of the world. Such inflation, and the deflation which has followed, have produced mental effects which we should study. Man acquired more desires; and as the reaction exerted economic pressure, mental unrest set in,

and the minds of men in the mass took up many doubtful theories.

To some, speculation seemed the easiest way to make money. After the crash they now balk at any continued efforts to exercise their mentality, and want some political Moses to lead them the easy way of "rising prices," instead of making the effort themselves to help production by work.

Then we have the men who think the world owes them a living of their own choosing and who are unwilling to change to meet changing conditions, and we have certain classes of labor who by unwise demands may destroy the industry of which they are a part. Then we have some people who are wilfully likely to become permanently idle and a charge on the community. These also deserve our sympathy, but should be sifted out of the mass.

Then we have many men who do mental labor, and non-agricultural and even agricultural laborers, who cry for redistribution of wealth through artificial means—usually through the medium of higher income for their services than they are worth, inheritance taxes, confiscation of excess income from those that save, debenture bounties to farmers, loans or bonuses to veterans, and doles, or other means of distribution; things which can only be done by borrowing and by using credit from our wealth and consuming it without producing more wealth.

Then we have certain classes—improvident men and corporations, unwise investors with decreasing earnings, and others with a feeling of incapacity or who are lagging—who desire government ownership as a panacea and the redistribution of wealth through devious means. They desire government ownership and the substitution of bureaucracy and political measures in place of the personal reward and incentive for effort which have made this country great.

As a matter of enlightenment let me quote, from an interesting article on the "Wealth of Nations," by Dr. W. R. Ingalls, a partial enumeration of the hysterical hodgepodge boiling in confused minds:

"Belief in too much wealth, in the impossibility of further farming, in perpetual unemployment of men, and in the failure of toilers to enjoy the fruit of their toil, sounds more like the findings of Alice in Wonderland than as the products of clear-thinking. In plain words, it is nonsense—all of it.

"In general, the thoughtless catch-phrases of the day are: Overproduction—Under consumption—Mass-production—Machine-production—Technological unemployment—Three-day weeks—Six-hour days—Wages not to be reduced—Buyer power must be preserved—Buyers should not strike—Doles must be given—Ex-soldiers should be pensioned—Bounties must be paid—Build pyramids—Impose tariffs—Avert Russian competition—Pacify the farmers—Government ownership and operation—Democracy ascendant—Crucifixion on the cross of gold—The capitalist system has wrecked itself, or is about to, and the communistic will supersede it—Uphold the price for wheat, but let us have cheap bread—Those who toil, the proletariat, shall at last receive the fruit of their labor."

It is an education to study such phrases collected in one paragraph and there are some germs of truth in the tangled web, but most of such catch-phrases as are quoted can be said to be in disregard of facts, of analysis, and of common sense.

All such heedless thought logically leads to that greatest fallacy and absurdity of all—that the more wealth we have as a nation, and the more goods, and the more surpluses we have of equipment to make wealth, the worse it is for everyone. Such mental wanderings in search of a panacea to take the place of work lead to loose thinking and slow down our progress, and they should be discouraged before they give us more trouble.

A GREATER "DEMAND" REQUIRED

As to our domestic affairs, the effect of the world-wide depression has been aggravated in many ways that are deplorable, but we seem to be over the crisis and on the up-grade. I believe we are beginning to balance our income and expenses by the savings we have made from the cutting down of living expenses through lack of money tokens or credit.

If we could eliminate some of the artificial restriction and class legislation and political diseases which beset us, and reduce taxation instead of increasing it, and revert to the laws of supply and demand in business, it would be a hopeful sign for a new era.

Stripped of its many disguises, the impulse behind prosperity is mental and physical work, and the prices to be received from the proceeds of such work and culture are subject to the laws of supply and demand. We have used many political expedients to raise prices of our products and they can only be disturbed with caution; but we must keep in mind that the laws of supply and demand are as sure as the laws of gravity and although they can be flouted and overcome for the moment, there is a persistent and almost irresistible force always inexorably working to force a recognition of that law when its principles are disregarded.

When prices fall, as they have by lack of demand at old prices, if any operation is to survive, the cost of production must be reduced. This can be done by reduction of wages, or by lowering the cost of materials, or by improved methods found to make more production per man, or by larger markets to allow greater production; or the output of the operation may be changed to meet more profitable markets. If labor and our combined efforts cannot meet these conditions there is unemployment; if the operation cannot meet these conditions there is a shut-down.

There is nothing new or mysterious or discouraging about such a requirement, it is the same invitation to engineers that we have always had, but it is more urgent because of this depression. No one wants wages and salaries to fall. We have worked for years to climb to our present wage plane. No one wants operation to shut down.

I think we can improve our methods and by proper research can find new uses for our surpluses as needed. By proper diversification of effort and proper distribution we can increase our markets in our own country, where most of our income has previously come from enlightened use of our wealth.

No one can feel that our living conditions and standards have been properly distributed, and there seems almost an unlimited demand for our wares and room for improvement in every direction. We seem to need leadership and millions of old-fashioned commercial

drummers to sell us immediate confidence in ourselves, and also by education and research to try to distribute our material progress more satisfactorily.

As to world conditions, this country's international customers are kept out of the market by their struggles with the political diseases which beset the whole world. The net result here and abroad is a clogging of the equitable distribution of prosperity, which must be cleared if we are to maintain our standards of living.

All human beings of whatever race and nationality are created with mental possibilities, and are susceptible of certain degrees of education and ambition. Yet two thirds of the population of the globe are living on a scale that should be of grave concern to twentieth century civilization, and they form one of our unavoidable responsibilities.

In this country of ours, with an abundance of the necessities of life and a surplus of the productions of industry, and the mentality to meet any world-wide competition in farm produce, industry, and transportation, there is no reason for an economic policy which permits five million men to be out of employment, while two thirds of the world needs and will want our wares for generations to come for improving living conditions. Judging by past experience, they must, in fact, have them or by stagnation be absorbed or perish.

Our present tariff is a grievance to our debtor nations because the articles they secured from us during the war and the reconstruction period now seem to require an almost prohibitive equivalent, in so far as our protective tariff permits them to pay us with goods at all. I believe reciprocity is as necessary a medium for the politically diseased abroad as it is for those at home, and that it would assist all in maintaining and improving living standards.

While our income from foreign trade is not financially compelling, it is of significant interest, and it has many possibilities that should have our immediate forethought and attention. I also feel that pioneering with reciprocity, by which I mean give and take in trade; and pioneering with education, by which I mean the spreading of the knowledge of the mental pleasures as well as of the physical pleasures our standards of living afford, in those sections which compose two thirds of the world, which is lagging behind the civilization we enjoy, would be of inestimable value to those backward sections of the world and would help us as well.

Mechanical Development Helpful

Labor-saving devices, machinery, and anything else that cuts down the cost of production of wealth or produces more wealth than is useful to the world are to be eagerly sought for. If we thereby thrust men out of one branch of employment they will be absorbed by new occupations that will be found. Just as steam engines and automotive inventions have absorbed our surplus man power in the past, without our conscious effort, new fields are here just ahead for our seeking.

We are not through improving living conditions, we are just beginning to see the necessity of research to find means for a more equitable distribution of things that lead to contentment, and the future holds far more advances than the past. If we can guide our efforts to properly distribute our mental and physical products among the mass of humanity wherever found, who are willing to work to pay their way in the world, within their means, we will progressively develop a demand that will keep wheels turning and that will also make us all more ambitious, energetic, helpful, and happy aids in the work of the world.

A Prominent Future for Engineers

The individual's thoughts are only suggestive in our scheme of things and are of value only if they can stimulate other minds to think. Speaking for myself alone it seems to me today that "the handwriting is on the wall," that the world has spent too much of its wealth, and that we are paying for our mistakes; that there are no panaceas or short cuts to avoid work, and we must all work to advance civilization. Our own people and the world need our mental and physical wares. If we can find a way to a more equitable distribution of our wealth and prosperity to all who are willing to pay their way by work, there will be a demand that will put all available men to work. For these and other reasons I expect an awakening to our responsibilities that will make the next ten years mentally and physically even more fruitful to all than the past twenty-five years have been.

Considering the political acts of the past twenty years, I expect 1930 to 1940 to be memorable years of opportunities for engineers, and I hope we will all take our place with the other forces that are trying to press forward and increase our usefulness to mankind.

We engineers owe a great debt to our profession for recording engineering progress, as it was made for us to use in our daily work. In fact, in this emergency you can pay in part (after your own family has been provided for), by making it a duty to help other men in the profession, who have not been so fortunate, to get employment of some kind and speed up the demand for production.

One word more, as to the present emergency with its problems to immediately care for the temporarily unemployed, as distinct from those unable to work. The Federal, state, and city governments and industry should see that the money available is used to give an equal amount of work to the greatest number possible of the needy who can work. If such agencies can conduct the work on a basis of a schedule of so many days work, per man, per week, beginning with a minimum number, and increasing the days per man as more work is provided, or as the unemployed are absorbed by outside needs, or other conditions permit, it will enable them to give the most effective aid to the greatest number.

The engineers' useful service in the present emergency should be to initiate or direct such work into channels that are for the benefit of the general public or the whole community, and speed up and help supervise the work, and above all to see that such projects do not compete with or cause an injustice on men already employed, without their voluntary consent. Even in this temporary matter we must use business economics to get any lasting result.

As soon as we have the emergency in hand and work for all, the way to prosperity lies in increasing the output per man per week, to try to replace wasted world wealth, and not by shorter working hours.

Railroading in the Northwest

A Review of Economic Developments Since the Earliest Days of Transcontinental Roads

By W. L. Darling

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Consulting Engineer, St. Paul

Real romance lies behind the extension of transcontinental railroads to Puget Sound. There still remain a few old-time railroaders who cannot forget the immense activity, the intense rivalries, and the frequent dangers of that westward surge. Among the gradually decreasing number of such veterans is Mr. Darling. He has looked back and has drawn upon a full memory to present to a younger generation some vivid recollections. Here he has recorded the activities he witnessed—from some of the earliest surveys to the modernization of great railroad systems, through the growing pains of youth to the full stature of maturity. This interesting story was presented on October 7, 1931, before the Technical Session of the Society's Fall Meeting in St. Paul.

Necessarily, a subject as extensive as railroading and an area as inclusive as the Northwest can be treated only partially within the limits of a single article. The territory concerned is that traversed by the three northern transcontinental routes, familiarly known as the Milwaukee, the Great Northern, and the Northern Pacific.

This area, which is shown in Fig. 1, extends from the Mississippi Valley and Lake Superior on the east to Puget Sound and the Pacific on the west. The country rises gradually from the bench land above Lake Superior to the foothills of the Rocky Mountains, or from approximately elevation 1,300 to elevation 4,400 above sea level, the latter near the towns of Livingston, Mont., on the Northern Pacific, and Blackfoot, Mont., on the Great Northern. The valleys of the Red, Jim, Missouri, Little Missouri, and Yellowstone rivers are from 400 to 700 ft. below the general land levels.

On the route traversed by the Great Northern, the valley depressions are not so deep as on the lines to the south, and there are but two mountain ranges, the main Rockies and the Cascades. There is no portion of this district that cannot support settlements of a fairly dense population; there is no approach to a so-called desert. Most of the mountain streams have fertile valleys, and the mountains themselves are largely mineral bearing. With normal precipitation, the entire agricultural district is well adapted to farming and stock raising.

Timber resources are rapidly decreasing. Northwestern Montana, Idaho, northern and western Washington, and Oregon are the remaining sources of supply, although originally Minnesota and western Montana were also covered with dense forests. Some timber still remains in those districts, but it has greatly diminished.

There are great mining resources in the Northwest. Coal, which is mostly lignite, is extensively mined. One field covers the entire western half of North Dakota and extends in a western direction into central Montana. In a paper published by the U.S. Geological Survey, a geologist estimates that within a depth of 300 ft. below the surface of the North Dakota fields, there are 500 billion tons of coal. In central Montana a field has been opened by the Northern Pacific that is conservatively estimated to contain 7 billion tons of recoverable coal, a portion of which is being mined by open-pit methods.

Fired with this coal, locomotives with a tractive power of 140,000 lb. frequently pull 4,000 tons over a 1 per cent rolling grade for a distance of 216 miles, in 10 hours. This coal is being used exclusively by the Northern Pacific from Dilworth to Spokane, a distance of 1,257 miles.

Iron ore districts are located in the northeastern part of Minnesota and the northern part of Wisconsin. From 1890, the year of the discovery of the Mesabi Range, to January 1, 1928, there were shipped from the range 815,000,000 tons, or about 58 per cent of all the shipments from the Lake Superior district. The total reserve tonnage of this great range is 1,200,000,000 tons, which will last for 30 years on the present shipping

Fig. 1. Territory Traversed by the Three Northern Transcontinental Rail Routes

basis of 40,000,000 tons yearly. Perhaps in no other part of the world has Nature been more lavish with her gifts than in the Northwest.

SURVEYS BEGUN EARLY

In 1853, Congress authorized Jefferson Davis, Secretary of War, to make surveys covering five sections, one of which was of the Northwest route. The Northwest survey was placed in charge of Isaac Stevens, a graduate of West Point, who was later connected with the U.S. Coast and Geodetic Survey and became the governor of Washington Territory. The survey was conducted in two divisions, with the western half in charge of Capt. George B. McClellan, and the eastern in charge of Governor Stevens himself.

The final report of the Governor showed that there was an easy route along either the Musselshell or Yellowstone rivers, it being possible to cross by any one of several passes on the usual mountain grades; that the Bitter Root Mountains could be avoided; and that the Cascade Range could be traversed by any one of several passes. He recommended the Cascade Tunnel route, while Captain McClellan insisted that the Columbia River route was preferable because of the snows in the passes of the Cascades, which he reported to be as much as 20 ft. deep. Since Governor Stevens did not agree, he sent to Snoqualmie, during a period of severe weather, an engineer named Tinkham, who reported but 7 ft. of snow. Later experience has demonstrated that the snowfall varies greatly in different years and changes with the elevation of the pass. Evidently Captain McClellan cited an extreme case, while Mr. Tinkham found a comparatively low depth, probably during a winter of light snow.

GRADES AND CURVATURE STANDARDIZED

It is interesting to note the economic reasons for adopting the basic elements of location—that is, maximum grade and maximum curvature. The Northern Pacific, which was entering a new country with little knowledge of the prospective traffic it must handle, adopted a maximum grade of 2.2 per cent through the mountain districts, and that of 1 per cent for use freely elsewhere. Probably these grades were chosen because they had been adopted by the railroads in the Middle West and were apparently suited to the country, resulting in economic construction. The attendant maximum curvatures were 10 deg. and 6 deg., respectively.

After it had developed the Red River Valley, the Great Northern proceeded westward. Appreciating the economy in heavy train loads, it used such gradients as were most economical, and continued to do so as it built westward, with the result that when improvements were necessary the roadbed did not need to be disturbed.

In its turn, the Milwaukee had the assurance of the full development of the Northwest, and the latest information in regard to the savings made by the other roads in low-grade operation. Realizing that its new line must be in keen competition with those already in existence which had chosen low grades, it adopted 0.4 per cent grades wherever practical, and mountain grades varying from 0.7 to 2 per cent.

In an economic sense, there is no doubt but that each road was correct in the grades it adopted. In the years prior to 1906 the Northern Pacific saved 25 years' interest on a large investment, although a small sum was spent for virtual grade improvements during the years from 1895 to 1897.

HARDSHIPS OF RAILROAD RECONNAISSANCE

The engineers on these early locations encountered severe difficulties. The whole country was a wilder-

CONTRACTORS LOOKING OVER WORK
On the Yellowstone River, 1880

ness, there being scarcely a settlement from Duluth to the Rocky Mountains. Any group of even two or three houses was generally close to a Government fort. In the mountains there were the mining towns of Butte, Helena, Deer Lodge, New Chicago, and Missoula, which had been settled from 1864 to 1870. West of Missoula, there was no settlement east of Fort Wright and the fur trading center of Spokane. Thence to the coast there was no town.

Northern Minnesota was a wilderness of heavy timber, muskegs, and Indian trails, difficult to travel over. Since there were no roads, all transportation had to be done by the men themselves, each carrying his pack on his back. During the day, while the axeman was cutting trails, the engineer would run lines, tramping back to camp after dark, and all the time fighting mosquitoes and small black flies. Tents were the only sleeping quarters. Beyond Minnesota, the country was open through to the mountains, and travel was by horseback and wagon. From the Rocky Mountains to the coast, it was necessary to use pack trains, each animal carrying from about 250 to 300 lb. The country was subject to frequent floods and, east of the Rocky Mountains, to extreme cold in the winter, the temperature frequently registering 40 deg. below zero.

A pack train for an engineering party along the Indian trails in the virgin forests is rather an imposing sight. I used one on a reconnaissance and preliminary survey made in the fall and winter of 1881, west from Missoula. Our outfit consisted of 20 pack-horses and mules, one riding broncho, and 16 men. The cooking, which was done with a reflector and Dutch ovens, was really excellent, and all were satisfied until we met another party

working from the west, which had a good cooking stove, aparejos instead of packs, and good mules for packing—a fine outfit generally. However, by that time our work was done, except for the walk back to Missoula.

There was a large amount of wild game—deer, antelope, elk, and immense herds of buffalo. The engineers were furnished rifles, one to each man, but these were seldom used except for game. Through North Dakota and to the Yellowstone, the U.S. War Department furnished protection for these parties against the Sioux Indians, but there were few instances of engineers being molested.

CONTRACTOR'S CAMP ON THE HEART RIVER
North Dakota, 1880

West of the mountains conditions were better. The climate was milder, and travel was generally through heavy timber and in river valleys, except from Spokane to the Cascade Mountains, where the country was open and the climate pleasing. In general, notwithstanding the arduous work and exposure, I think the men who stayed throughout our surveys were well satisfied. The experience they gained was of value. They were as well cared for as practicable, and the food was as good as possible under the circumstances.

EARLY CONSTRUCTION PROCEDURE

Construction methods in the old days were much cruder than at present. The work of grading the Northern Pacific east of the mouth of the Flathead River was done by contract. Supplies were hauled by mule teams—generally 16 mules to a wagon, with a trailer—which could be conveniently handled in average country under usual conditions. But when an obstruction was encountered, as, for instance, a hill, bog, or river crossing, the train was generally doubled—that is, the trailer was taken off and the wagon hauled over the obstruction, the "skinner" going back after the trailer and then coupling on again.

Grading tools were short-handled shovels, wheelbarrows, drag scrapers, "mormons" or tongue scrapers, carts, and cars, and track. Track tools were hand-churn drills, stone boats, and carts. The general contractors let their work in small sections to "station men" and to small subcontractors, supervised by walking bosses. Station men generally were given work not adapted to scrapers, usually in wet ground, gumbo soil, and rocky districts, or short, rocky cuts. They would cast in the low embankments and then, if necessary, top out with wheelbarrows. This method was frequently used on embankments as high as 12 ft., the men working from daylight until dark, often 16 or 17 hours. In general, the output of these long hours would be from 25 to 30 cu. yd. per man, sometimes even as high as 40 cu. yd. I remember one scraper outfit, consisting of five yoke of oxen dragging the scrapers, which completed an embankment 10 ft. high and about one half mile in length. This was perhaps the first and last ox outfit on the road. Judging from the subcontractor's remarks as the work progressed, he did not get rich.

Embankments were formed by dumping material from cars at the end, the dump man keeping the embankment in shape. Embankments of 65 ft. in height were made in this way. The construction track consisted of small ties, on which were laid 6 by 6-in. timbers. Steel plates were spiked to these stringers for rails.

All structures on the road were wooden, usually framed on the ground. Pile bridges and culverts were of wood throughout, and 56-lb. rail was used. Cross ties, usually cut close to the right-of-way, were piled

ENGINEERS' CAMP IN THE BAD LANDS
North Dakota, 1879–1880

conveniently and then hauled alongside the grade to be placed as the track progressed.

Wages were generally $1.50 a day for ten hours. The foremen were old-time bosses in every sense of the word. Grading prices varied according to the location and the difficulty of the work. The contractor's rates for the first 50 miles west of Missoula were 17 cents per cu. yd. for

earth, and for that portion done by the Mormons, 34 cents per cu. yd., the increased price being due principally to the long haul of supplies and plant. From the south of the Flathead River toward the west the work was done by railroad forces employing mostly Chinese laborers.

At first, the Northern Pacific roadbed had no ballast, and it was painful at times to see the effort that some of the superintendents made to obtain it. I well remember one who used to set a car near the ash pit to collect cinders, sending them out in the light trains, then having the section men unload them and tamp them under the track. Many miles were ballasted in that way, without authority and seemingly without expense.

It was a great relief when the road was reorganized and money became available for improvements. To effect the reorganization, a new road had to be built under a different charter. One three miles in length was constructed, beginning at a point in Minnesota and extending in an eastern direction into Wisconsin toward Lake Superior, connecting at each end with the Northern Pacific. This new road bought in the old Northern Pacific at the receivers' sale.

The science of location, which is the fundamental principle in controlling the cost of a revenue ton mile, has been materially improved. Since 1890, values have been given to distance, rise and fall, gradients, maximum grades, and curvature, all based on gross tons to be moved.

A heavy ballast section is used for ordinary and washed gravel; creosoted ties are standard; there is no rail in the main lines weighing less than 90 lb., and this is being replaced with 110 to 130-lb. rail, with proper connections; water and fuel stations are modern; the main lines are signaled throughout; side tracks have been lengthened from 1,700 to 7,600 ft.; and the curvatures are being lowered to less than 3 deg. where it is practicable. Grades have been reduced, as is shown in Table I, and the power so distributed that from 3,500

Custer's Lookout
Near Sentinel Butte, N. Dak., 1880

to 4,000 tons can be hauled over any division with helpers. The preponderance of tonnage is in an east-

Table I. Miles of Maximum Operating Grades—Eastbound from Seattle to St. Paul

Roads	Per Cent of Grade: Less than 0.3	0.3	0.34	0.4	0.67	0.75	0.8	1.0	Total
Great Northern	0	520	0	702	120	0	435	0	1,777
Northern Pacific	691	0	105	782	0	110	0	208	1,896

bound direction. The Great Northern uses 5 helpers over a distance of 124 miles, while the Northern Pacific uses 9 helpers over a distance of 102 miles.

In 1906 another construction era commenced. The Milwaukee started to build from Mobridge to Puget Sound by way of Butte. The fact that Butte must be on the main line determined the location of the road as far west as Missoula. From Missoula there were alternate routes, and the fact that a feasible pass was found through the Bitter Root Mountains may have determined the route taken. The one selected required the crossing of four mountain ranges. The most easterly range, consisting of the Belt Mountains, was crossed with 1 per cent grades; the second, or Main Rocky Mountain divide, required grades of 1.7 per cent on the east and 2 per cent on the west side; the third, the Bitter Root crossing, required 1.7 per cent on each side; and the fourth, the Cascade, required 0.7 per cent

A Group of Contractors in the Bad Lands
Capt. Walker's Camp, North Dakota, 1880

on the east and 1.74 per cent on the west side. However, the low grade on the east side was accomplished by introducing a 2.2 per cent grade 76 miles to the east by which to climb the west slope of the Columbia River.

The elevation of the summit of the various lines through the mountains is given in Table II.

Table II. Summit Elevations of Three Railroads

Road	Range: Belt Mts.	Rockies	Bitter Root Mts.	Cascades
Milwaukee	5,800	6,347	4,170	2,564
Great Northern . . .	..	5,211	..	2,881
Northern Pacific . . .	5,860	5 877	..	2,837

Since the Great Northern was built on a lower gradient, it did not require as many improvements to its line as did the Northern Pacific, but a bad situation developed in its Cascade crossing as a result of snow. So resort was had to a major piece of construction including the building of a $7^3/_4$-mile tunnel, which lowered the summit 500 ft. and greatly improved the line from the tunnel in an easterly direction to Wenatchee by materially reducing the curvature. The whole improvement resulted in the elimination of the snow problem and the electrification of the mountain section from Wenatchee westward. Record speed was made in its construction, the total time from start to finish (1930) being three years.

DEVELOPMENT OF BRANCH LINES

In agricultural districts, branch lines were started in the wheat growing sections as the country developed. Most of them were built before the advent of the truck, so the distance between the branches, which determined the length of the farmer's haul to market, was one of the controlling features. The maximum distance traveled in one day would be about 20 miles with the load and the same returning with necessities for the home. The farmer could not afford to remain overnight en route. He was generally removed from post-office facilities, and could not know the market for his produce.

Character of soil had a great bearing on the location of railroad branches. Often a district was found where soil and water facilities were better than in adjoining localities. A farmer would settle in such a place and a colony would rapidly grow up around him, demanding railroad facilities.

As these branches were generally built in short sections the country would be settled around the end of the track, and gradually beyond, until the distance became too great for hauling. Occasionally a farmer had to haul a distance of 60 miles, but the track was generally kept well within the 20-mile limit, so that the country could be settled farther out.

With the advent of the truck, the necessity for branches in the agricultural districts has ceased. For distances of from 50 to 75 miles, the truck will answer every purpose of the train, except for carrying mail, which must be handled by automobile. As soon as a branch is built and business appears, the state may construct a competing highway, generally immediately adjoining the railroad. Under these conditions, is it wise to build more branches?

Today, in the district extending from the longitude of the Twin Cities in a westerly direction to the Pacific Coast, and from the Canadian boundary south for 400 miles, there are about 18,000 miles of railway. If this mileage were built in parallel lines 50 miles apart, there would be 10 complete railways from the Lakes to the Pacific Coast.

THE MOTOR TRUCK A DISTURBING FACTOR

Probably in this district railroad building is nearly finished, but there still remain improvements to be made to decrease the cost per revenue ton mile, and to provide better service to the public in the way of safety, lower rates, dispatch, convenience, and comfort. The advent of motor equipment into transportation has introduced a new element that is highly competitive; it is an economical tool that must be recognized.

Pure railroad transportation is the hauling of goods and passengers, but largely as a result of competition the railroad has become a distributor as well. Under certain conditions, distribution is more economical by truck and of greater convenience to the shipper. Does this mean that it should be divorced from transportation and that both should remain under the same control yet be operated separately?

Distribution by rail requires six handlings of freight, while but two handlings by motor are necessary. There is therefore no doubt that, for certain distances where the cost of motor service equals that by rail, the motor is the better tool. Several roads are now experimenting in this direction and sooner or later some economical method of using motor vehicles doubtless will be worked out.

It is a question whether the separation of distribution from rail haul should not be carried still further by applying it at terminals in connection with unification of ownership. Terminal unification has been studied, and examples of great economy have been shown on paper. It is believed that competition between roads is the reason for its failure in practice.

This competition is fair and must be taken care of before the roads agree to work together. For example, in a certain terminal, one road may have particular ownerships, which are favorable to it in obtaining freight. To that road this value is real, and although it cannot be considered for rate-making purposes yet it must be considered for commercial purposes. Such a value can be determined by the courts or by arbitration. If it is determined, there is apparently no reason why roads cannot cooperate.

Would not the divorce of distribution from transportation, with the use of motor service, tend to increase freight schedules and reduce freight equipment; and would it not further tend to replace heavy equipment not working to capacity with motors which require more labor?

Is not the cost of distribution in large cities a matter between the railroad and the shipper—that is, should it not be a local problem for the shipper, the railroad, and the city? Should not the cities, through their planning boards, be interested in the manner of distribution, the location of industries and street crossings, and the use of steam versus motor; and should there not be a general plan toward which cities can work with assurance in making their own improvements? These and similar questions are forcibly impressed on anyone who studies railroad economics in recent developments.

Open-Pit Iron Mining on the Mesabi Range

Mining Methods, Markets, and Taxation Handicaps Analyzed

AN unusual opportunity was given to those who attended the St. Paul Meeting, that of visiting the Mesabi Iron Range, of which Hibbing, Minn., is the center. There is located the largest man-made hole in the ground, from which a yardage nearly equal to that excavated from the Panama Canal has been removed. This one pit covers 1,060 acres, is 350 ft. deep at its deepest point, and contains 66 miles of trackage. These two articles, abstracts of papers read before the Technical Session on October 7 by Mr. Bennett and Mr. Davis, present the outstanding features of the Mesabi iron mining industry. They deal with ore mining practice, with problems raised by the demand for steel—of vital importance to all civil engineers—the economic utilization of the lower grade ores, and the burdens of taxation.

Trend of Mining and Concentrating Practice

By Russell H. Bennett
Mining Geologist, Minneapolis

THE Mesabi Iron Range may be counted as one of the great natural endowments of the United States. It is in large measure responsible for our cheap steel, and economists generally agree that cheap steel has been the material basis for our unexampled industrial development. Viewed in broad perspective the Mesabi Range takes rank with the few great natural heritages that have profoundly affected the destinies of nations. It is of the order of the Rand in South Africa, of the Basin of the Saar, and of the recently discovered Rhodesian Congo copper deposits.

Considered in the large, its red hematite is the arterial flow which, pulsing eastward and joining with the dark veinous flow of coal and oil, animates the industrial heart of the nation. Of all the iron ore mined in the United States the Minnesota mines supply 55 per cent; and the Lake Superior district, of which Northern Minnesota is a geologic and economic part, 65 per cent. These percentages are for the five-year average, 1926 to 1930, inclusive.

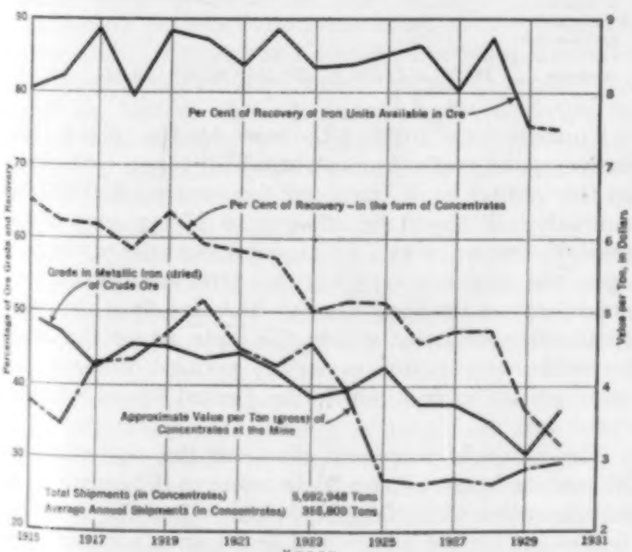

Fig. 1. 15-Year Record of an Active Wash Ore Mine

The primacy of the Mesabi, both regionally and nationally, is attributable to three factors: the abundance and purity of its ores; the manner of their occurrence; and its location, close to the Great Lakes.

Hull Rust Open Pit Mine
The Biggest Man-Made Hole in the Ground

The last-named advantage it shares with the other Lake Superior ranges. If it were possible to value separately the different factors, this, with all that it connotes, would probably stand first. There are, by way of illustration, iron ore deposits in Brazil that in size dwarf the Mesabi, and in grade are much richer. Yet they have so far remained undeveloped, being from 300 to 400 miles distant from the coast.

To transport a ton of ore from the Mesabi to Pittsburgh costs \$3.02. The rail haul in the two stages is about 230 miles; the lake haul, about 850. The charge for the former is \$2.19, for the latter, including unloading, 83 cents. While no detailed figures are available, it is probable that the lake carrier earns as much from its 83 cents as the rail carriers (under present conditions) from their \$2.19. The relative rail and water rates make interesting—and somewhat ominous—an inquiry

into the effect that the proposed Great Lakes-St. Lawrence Waterway will have on the iron mining industry.

The Mesabi ores are found immediately below a mantle of glacial drift, and before the Pleistocene ice invasion, which doubtless planed off a substantial

STEAMING ORE DURING FREEZING WEATHER
Duluth, Mesabi and Northern Railway Yards at Proctor, Minn.

thickness, they lay at the erosion surface. There are none of the great cross faults, abrupt flexures, or destructive igneous intrusions that characterize many of the Western mining fields, and certain of the Michigan and Wisconsin ranges. There is, however, a most interesting field for geological investigation in the genesis of the ores. The tonnage of ore in the Lake Superior district is vast enough, but the figures become almost insignificant when set over against the total volume of the parent iron formation from which these ores came. How such almost astronomic quantities of iron were deposited in the remote Huronian period, and how, once deposited, certain parts of the formation were altered into ore, is a problem that has challenged the powers of many geologists and chemists.

OPEN PIT MINING MUCH LESS EXPENSIVE

In addition to being flat-lying and tabular, the Mesabi ore bodies are at shallow depth, being overlain only by the mantle of glacial drift, or in certain instances only by their parent iron formation and the glacial drift. The last mentioned varies in thickness from a few feet to as much as 250 ft. The ratio of cubic yards of stripping to tons of ore underlying is the chief yardstick applied in the selection of the method of mining, which may be open-pit, underground, or some combination of the two, such as milling or tram-to-pit. The open-pit method is the most desirable, being cheapest in operating costs, safest, and most flexible.

Employing power shovels (steam, Diesel, electric), railroad haulage, large diameter drills and consequently heavy blasting charges, and other high efficiency tools, it has much the lowest mining costs. The rapid advance of mechanical design has greatly favored the open-pit method. The ore from a pit is at no point the product of hand labor. That from underground, although at several points expedited by new mechanical devices (such as the power scraper), is still the product of pick-and-shovel labor. Sociologically considered, the trend toward open-pit mining, like technical advances in parallel industrial lines, is unfortunate, for it makes its proportionate contribution to technologic unemployment.

The visitor to the range sees power shovels working apparently haphazardly over the pit areas, or if he goes underground he finds gangs of miners working widely separated ore faces. The reason for this apparent diffusion of effort lies in the necessity for close grading of the ore. The shovels in the open pit, the gangs of miners underground, are so located that their outputs, when combined in the proper proportions, give the desired grade.

The trend of open-pit and underground operations is shown in Table I, covering all Minnesota mines for the years from 1926 to 1929, inclusive. It will be noticed that in 1926 the percentage of underground ore produced was 24.3; that in 1929 was 19.3. The table also shows the costs per ton, exclusive of taxes. With certain additions this table is that shown on page 65 of Chapter V of the Twelfth Biennial Report of the Minnesota Tax Commission.

TABLE I. TONNAGES AND COSTS FOR OPEN-PIT AND UNDERGROUND MINES IN MINNESOTA

Year	Tonnage Mined	Per Cent of Total	Average Cost Per Ton: Development	Mining	Royalty	Total Average Cost per Ton
OPEN-PIT MINING						
1926. . . .	31,535,909	75.7	$0.288	$0.414	$0.435	$1.137
1927. . . .	27,383,370	75.1	0.305	0.459	0.438	1.202
1928. . . .	29,696,918	77.1	0.276	0.382	0.445	1.103
1929. . . .	37,862,622	80.7	0.260	0.349	0.449	1.058
Totals and averages .	126,478,819	77.3	$0.280	$0.397	$0.442	$1.119
UNDERGROUND MINING (INCLUDING TWO MILLING OPERATIONS)						
1926.	10,126,581	24.3	$0.088	$1.587	$0.445	$2.120
1927.	9,091,179	24.9	0.089	1.595	0.466	2.150
1928.	8,835,085	22.9	0.068	1.510	0.447	2.025
1929.	9,060,289	19.3	0.055	1.467	0.447	1.969
Totals and averages . .	37,113,134	22.7	$0.075	$1.542	$0.451	$2.068
Grand totals and averages for both methods . .	163,591,953	100.0	$0.234	$0.657	$0.444	$1.335

To these total costs at the mine for the open-pit and underground methods must be added taxes, amounting on the average to 51 cents per ton, or over $20,000,000 annually. Taxes alone amount to 27 per cent of the total of all other costs. It is evident that the tax burden upon the mines is very heavy. Iron ore bears a very much heavier tax in relation to its value than any other commodity produced within the state, or for that matter within the nation, excepting perhaps tobacco and commodities against which the United States levies an excise tax.

The practical economic effect on the nation of the Minnesota iron ore taxes is the same as if Minnesota, in contravention to Section 10 of Article 1 of the Constitution of the United States, had levied an export tax upon iron ore.

It will be noted from Table I that a ton of ore can be secured on the average for 95 cents less from an open-pit mine than from an underground mine. In the case of a commodity selling for about $2.65 at the mine this is, it will be agreed, a large discrepancy. It might well be asked why any underground mining is done at all. The answer is partly that the mining companies have large capital investments in underground mines, made at a time when there was not the present disparity in costs. Because of these investments, it is in certain cases cheaper to amortize them by operating the properties than to forego all return by shutting the mines down.

There is another, and in a year such as this, a weighty consideration in the desire to give the widest possible employment to the population of the mining towns. The number of men employed in mining a given quantity of ore from underground is from two to three times that employed in producing the same quantity from an open pit.

In 1929 the percentage consumption of steel by the different industries was, according to *Steel:*

Railroads	Automotive	Building	Oil, Water, and Gas	Export	All Others
18.44	17.57	14.70	9.01	4.83	35.45

The percentage for automotive uses by no means represents the true influence of the automobile upon consumption. The percentage given is that entering directly into automobile manufacture. Obviously the automobile has stimulated the consumption of steel in all other categories. In that of oil and gas its influence is at once apparent; in building it is perhaps less so, yet the steel used in garages, resort hotels, and such structures as vehicular tunnels, automobile factories, and accessory plants, amounts, both relatively and in the absolute, to a substantial figure. Even in that of railroads it is by no means absent; the automobile has made necessary the construction of elevated crossings and of special automobile freight cars.

In an attempt to express quantitatively the importance of the automobile to the Lake Superior district and to the Mesabi Range, I have sought a figure for the average weight of steel per unit (passenger car and truck) of production.

A recent personal communication of the National Automobile Chamber of Commerce concludes, after a discussion of the various factors, that a safe present-day figure to use for the calculation would be 1,800 lb. To this I have seen fit to add 200 lb. to represent the additional consumption of iron and steel per unit which varies directly with production. In this 200 lb. are included tools and dies, accessories, and garages.

The figure of 2,000 lb. is of course expressed in terms of finished steel (except for gray iron and malleable castings). To convert this sum into terms of ingots, to which ore ratios can be applied, it is necessary to make allowance for losses in the manufacturing processes. These losses I have taken at 25 per cent. The resultant figure is 2,666 lb., or, in terms of gross tons, 1.19.

Since almost all the steel used in manufacturing automobiles is derived from Lake Superior sources, we can, using different ore ratios, establish ore consumption figures for varying stages of automobile production. This is done in Table II. The ratio of 1.14 tons of ore per ton of iron and steel used is the average for the nation in 1929.

It is interesting to note that the annual automobile replacement demand, on the basis of total registrations for 1930 (26,524,000 cars and trucks), is, according to the method of calculation of the National Automobile Chamber of Commerce, about 2,900,000. This is of course on the assumption that the same number of people will want to own the same number of cars, an assumption that we should not take, I believe, as entirely self-evident. All in all one must assign to the automobile transcendent importance in the steel industry of the nation.

Stripping Overburden with Electric-Drive Shovel
Caterpiller Shovel Mountings Replace Those of the Railroad Type

Pertinent questions in this field suggest themselves. Has the congestion of highways and streets grown beyond the point where there is still a margin of pleasure to the car owner after subtracting the demands made upon his store of nervous and physical energy? Is the sense of freedom, of emancipation, which motoring gives real or illusory? There is some evidence that it is the latter.

Table II. Annual Demand for Lake Superior Iron Ore Directly Attributable to the Automobile

Calculated at 1.19 Gross Tons per Unit

Number of Units (Cars and Trucks)	Tons of Ore At Ore Ratio of 1.14 to 1
2,000,000	2,713,200
3,000,000	4,069,000
4,000,000	5,426,400
5,000,000	6,783,000
6,000,000	8,139,000

One's environment is not substantially changed, if one lives in a populous area, by a journey of less than a hundred miles; the recreational value of the automobile diminishes with the increasing traffic and with the destruction of fish and game, for which it is largely responsible. The motorist must also contemplate greatly increased chances of being involved in an accident. There is this difference between 1921 and 1931—and it appears to be a vital one—that there were then 9.7 automobiles per hundred population, and there are now 21.5.

It is generally recognized in mining practice that steam-railroad haulage for open-pit mines is very ineffi-

cient. In mining, the necessarily heavy grades, the frequent shifting of track, and especially the large proportion of idle time for locomotives, are drawbacks apparent to the most casual visitor. Electrification of haulage reduces transportation costs, and even although

LARGE STEAM SHOVELS LOAD ORE
Double Railroad Mounting

its first cost is large, it may be expected to be increasingly applied.

Progress in haulage may also take another direction in the future. Coal mines are now using conveyor-belt transportation, and the application of this method is proposed by the engineering staff of at least one Mesabi open-pit mine and is being investigated for an underground.

The greatest part of the large savings in mining cost, which, as we have seen, have put the open-pit method far ahead, results from the improvement of digging machinery. The first power shovel was the old Atlantic type, mounted on railroad trucks. When its chain falls and huge sheaves were replaced by a steel cable with its light blocks, a great advance in capacity and in digging power was achieved. The railroad truck mounting was retained until the caterpillar mounting was perfected. This was an even greater advance; the shovel was made mobile, and a large pit crew eliminated.

An advance of equal magnitude is the recent trend toward electric shovels. In one operation with which I am familiar, a change from steam shovels to an electric shovel made at the outset of this season indicates, on the basis of equivalent yardage handled, a saving in mining cost of 32 per cent. The new electric shovel with a dipper capacity of 5 cu. yd. replaces one intermittently used, and two continuously used, steam shovels of the railroad type with dipper capacities of $3^1/_2$ cu. yd.

Practice in underground mining has not remained stationary although, because of inherent limitations, its advance has not been as rapid as that of the open-pit method. The principal innovation, now some eight or ten years old, is the underground slusher system—essentially one of scrapers pulled from air or electrically driven winches. The winches are usually mounted in recesses at the ends of the working cross-cuts, and pull ore to the cars from the stopes, which are turned off at 90-deg. angles both ways from the cross-cuts. Substantial savings in ore handling costs between the working face and the cars are effected by the slusher system.

UTILIZATION OF LOWER GRADE ORES

Perhaps the most interesting development of modern iron mining is that of ore concentration, since it carries with it the answer to the oft-repeated question, "How long will our iron ore last?" About one third of the tonnage currently shipped from the Mesabi Range is beneficiated in some manner. The different methods of treatment are washing, crushing and screening, sintering and drying. Jigging, which was formerly applied by itself, is now an adjunct to the washing process, which is by far the most important in point of tonnage treated, accounting in 1929 for about 13 per cent of the total tonnage shipped from the range.

In concentration lies the ultimate future of the Mesabi Range. Recognizing this, the mining companies, the State of Minnesota, and the U.S. Bureau of Mines are all devoting much time and money to the improvement of present concentrating methods and the discovery of new ones. The life of the range is distinctly and measurably limited if merchantable ores only be considered. The estimate of the Minnesota Tax Commission of Mesabi merchantable ore stood on May 1, 1930, at 1,142,000,000 tons. The average shipment for the past ten years has been 33,200,000 tons per year. Dividing the first figure by the second gives a quotient of 34.4 years.

When, however, ores susceptible of beneficiation are taken into consideration, the life of the range becomes, if not incalculable, at least beyond the concern of this and many succeeding generations. Indeed it becomes impossible to fix a term for the life of the western Mesabi lean ore deposits amenable to the present washing process, that is, to a process already worked out and now in use.

In concluding this brief discussion of concentration, it is perhaps well to point out that in all planning and experimenting the engineer must keep uppermost in his mind the fact that, if any process or machine is to have value for iron-ore concentration, it must be very cheap in operating cost and have large capacity. Iron owes its primacy in the world of metals to its cheapness; practices and methods evolved in non-ferrous metallurgy are not available unless they can be made to conform to the foregoing specifications. Lead, for instance, sells currently at 4.2 cents a pound; iron (in the form of pig iron) for 0.78 cent a pound.

We may expect, I believe, a constant advance in the technology of iron ore at the present, or even at lower, price levels. In studying the history of the Mesabi Range mines (many of which have been long-lived) we see practice improving steadily throughout periods of both rising and falling ore prices, and as a mine goes from richer to leaner ores. In fact, if there is any measure of the rate of improvement, it is not that of price or even of volume, but rather of the amount of engineering skill applied. Mining companies are increasingly disposed to place engineers in new positions. A property which ten years ago may have had as its only engineer a surveyor, may now have an engineer in charge of surveying and mapping; one in charge of blasting; one in charge of concentration; one in charge of haulage; and others.

Finally, I should like to submit a graph (Fig. 1) from which much knowledge—perhaps as much as from many score printed pages—concerning the future of the iron ore industry may be gleaned. It is the record of an active wash-ore mine on the western Mesabi in the years from 1915 to 1930 inclusive. It was chosen because it was not a typical property, being definitely below the average in grade of ore, and above the average in mining and concentrating practice. Its material has been for many years second and third grade wash-ore material containing a large admixture of unaltered taconite and a large proportion of chunks in which the ore is "frozen" to the rock, thereby necessitating crushing.

It will be noted that the grade of ore mined and the mine recovery have on the whole declined throughout periods of rising and falling prices. That the decline in mine recovery—that is, the percentage of concentrates recovered from the crude ore mined—is not owing to poorer mill operation, but rather to the taking of progressively leaner ore material, is shown by the curve for recovery of iron units, which holds relatively stable for the life of the property. The significance of the decline in grade is that, if the practice prevailing at this mine be applied to other areas, with every decline of a point in iron analysis, many millions of tons of ore (in terms of concentrates) are made available on the western Mesabi.

The mine was theoretically dead several years ago; that is, the estimate of ore based on practice prevailing in 1915 was exceeded several years ago by shipments. The advance in practice that has prolonged its life was made, it should be noted, step by step all along the line—stripping, blasting, digging, hauling, concentrating—and without the benefit of radical innovations such, for instance, as magnetic roasting. The fact that this property is still operating at a profit on the kind of material available goes far to reassure any who have doubts concerning the length of life of the Mesabi, or who are oppressed by the possibility that Mesabi ore—the chief support of the country's greatest material blessing, cheap steel—will be exhausted.

There is just one way in which the development of the Mesabi Range can be arrested and its life curtailed. That is for the Legislature of the State of Minnesota to continue to add tax upon tax, to continue the steady increase in the present onerous and discriminatory burden upon the mines. The progress which the men of the industry are making is of necessity slow and labored; the advance of many years can be wiped out at one stroke of the legislative pen. The utmost efforts of the miners, from manager down to mucker, cannot long avail against the levying of increasing taxes, and the nation, suffering all the hardships attendant upon the dislocation, will then have to seek its iron ore elsewhere.

Economics of the Minnesota Iron Mining Industry

By E. W. Davis

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Iron ore in the State of Minnesota may be divided into two classes, high-grade ore and low-grade ore. High-grade ore is the material that is now being mined and shipped to the blast furnaces, part of which is not of sufficient quality to be used without the removal of some of the impurities. But the methods now in use for the beneficiation of these ores are very simple and are applicable only to a small proportion of our iron ore.

Data secured from the Tax Commission show that there is in Minnesota sufficient iron ore to last about 35 years. In this estimate is included all the ore of a quality that can be shipped direct or beneficiated by the simple processes now in use. This is the material that is now being taxed by state, country, and village authorities, and which has been classed as high-grade ore.

Immense Supply of Low-Grade Ore Available

In addition to this high-grade ore, the state contains immense quantities of low-grade ore not now being used, which pays little or no tax because it is of no commercial value. While the high-grade ore will be exhausted in 35 years, this low-grade ore, if utilized, will last for several hundred years, and it is therefore of great importance to the state to stimulate its utilization. The state recognizes the need for developing methods for utilizing the low-grade ores and makes appropriations for the necessary technical investigations. However, at the same time it adheres to a policy of taxation that will actually prevent this ore from being used. Thus, it appears that the utilization of the low-grade ores is closely associated with our taxation methods and an understanding of these is necessary for an understanding of the problems connected with the establishment of the low-grade iron ore industry.

Method of Taxing the Ore

Now consider the attitude of the State of Minnesota as exhibited by its taxation policies. At the present time the mining companies pay three varieties of taxes: the ad valorem tax, paid yearly on the value of the ore remaining in the mine; the occupation tax, on the profit that the mining company makes per ton of ore shipped, the method for determining which profit is defined by law; and the royalty tax, on the amount of money paid by the mining company to the fee owner. The occupation and royalty taxes go entirely to the state, but about 90 per cent of the

ad valorem tax goes to the counties, townships, and villages in the mining districts. The total tax paid amounts to about $22,000,000 per year, which is about $0.50 per ton of ore shipped. Of this, the ad valorem tax amounts to $0.39 per ton, and the occupation and royalty taxes together amount to $0.11 per ton. The occupation and royalty taxes are paid on the tons of ore shipped, and if no ore is shipped practically no taxes are paid. The ad valorem tax, on the other hand, is like any other tax on real estate and personal property and decreases as the value decreases, or, in other words, the longer the ore is left in the ground the greater the total tax that must be paid on it. The tendency, therefore, is for the mining companies to mine and ship ore as rapidly as possible and surrender the lease as soon as the available high-grade ore is gone. The result is that this ore will be practically exhausted before the low-grade material is given much consideration. Then, if the mining companies cannot find cheap high-grade ores elsewhere in Nova Scotia, South America, or Africa, they may be interested in utilizing the low-grade Minnesota ores. Some of the larger steel companies are already buying and leasing large holdings of high-grade ore in foreign countries with the expectation of stopping their Minnesota operations when they will have exhausted their holdings of high-grade ore.

MINING IRON ORE UNDERGROUND WITH SLUSHERS
Mesabi Range, Minnesota

Another feature of the ad valorem taxation system is that, as soon as it is demonstrated that the low-grade ores have some value, they will be taxed by the state, counties, and villages as long as they last. No one could possibly afford to pay the ad valorem tax on this low-grade ore for a period of one or two hundred years, and therefore no one is much interested in developing this industry. We are faced by a situation in which the state is appropriating money technically to develop an industry that cannot be developed under its present system of taxation. Of course, the technical difficulties depend upon the laws of nature, which cannot be changed, while the taxation difficulties result from the laws of the state, which we should be able to change.

At the present time on our iron ranges there is a large, well financed mining organization, which is well established and in large-scale operation. The mining companies are taking our best ore, and when this is gone will move elsewhere and leave us nothing but an enormous tonnage of low-grade material that may or may not be used in the far distant future. This is apparently what the State of Minnesota wants them to do, as the taxation methods are aimed entirely in this direction. It would seem much wiser for the state to more nearly assume the attitude of a fee owner and do everything possible at the present time to encourage the mining companies to utilize the enormous tonnages of low-grade ore before the high-grade ore is gone.

After it has been demonstrated economically by large-scale operation that the steel companies can, without question, secure their requirements of iron ore from our low-grade deposits for the next several hundred years, their interest in foreign ores will disappear, and we will have an established mining industry that is practically permanent. Ontario, which has considerable low-grade ore and but little of merchantable quality, now offers a bonus of about $0.50 per ton for all ore mined in that province. This is done for the purpose of encouraging the establishment of a low-grade iron ore industry. Why should not the State of Minnesota, which has already collected a total of over $300,000,000 from the mining industry, begin to take a little more encouraging attitude toward the low-grade ore industry and, either by a change in taxation methods or by a bonus system, attempt to stimulate the mining of these ores?

TAXES ON MINERALS SHOULD FORM PERMANENT FUNDS

The aggregate of all taxation paid by the mining industry in 1929 was $22,082,748. Of this total, $6,423,585 went to the state, $3,290,144 to the counties, and $12,369,019 to the townships, cities, and villages in the mining districts. These sums paid by the mining companies each year are entirely spent, with the exception of less than $2,000,000, which goes into permanent trust funds for the university and the schools of the state. Of the total of about $300,000,000 that the mining companies have paid as taxes since the beginning of the industry, there is left at the present time only about $14,000,000 in the permanent funds. Assuming that the average tax of $0.50 per ton on high-grade ore will continue over the next 20 years, the mining companies will have paid a total of about $750,000,000 in taxes, and of this only about $50,000,000 will remain in permanent trust funds. In considering this situation, it must be remembered that when the ore is gone, there will be nothing left to tax. It is in a different category from city properties or farm lands. These will, of course, pay taxes indefinitely and there is no reason why the taxes from these sources should not be expended as received. We are actually spending our capital, however, when we spend the money received from taxes on minerals. This is, of course, a very short-sighted policy, and it would seem that the interest only on the money received as taxes on mineral wealth should be spent. When the ore is gone, we will have spent all but about 6 per cent of the money received from it, and this is about all we will have to show for the wonderful ore deposits which the state contained.

It seems that a very much larger proportion of the income from taxes on ore should go into permanent trust funds. If all the money received from taxes on ore were to be saved, 20 years from now we would have trust funds amounting to about $450,000,000, which at 5 per cent

interest would yield $22,000,000 per year, about the same amount as is now received annually by direct taxation of the industry. All of this is, of course, a grand speculation and such a policy might be injurious to the towns and counties associated with the mining industry. It would, however, be of great benefit to the State of Minnesota.

LOW-GRADE ORE TREATMENT MUST BE DEVELOPED

It is obviously to the advantage of the state as well as of the counties, townships, and villages to utilize the enormous tonnages of low-grade ore that are to be found on our iron ranges. Technical means are available at the present time for producing merchantable ore from this low-grade material, but without more experience in its actual commercial treatment, attractive estimates of costs cannot be prepared. After large plants have been established and operated for a few years, means will undoubtedly be developed for reducing operating costs to a point where a reasonable profit can be made. This has been the experience in many other branches of the mining industry. However, for this industry to become established on an operating basis, it must be directly encouraged. It would seem that the state could well afford to encourage an industry for the treatment of these low-grade ores, especially if a larger proportion of the taxes on the high-grade ores were put into permanent funds.

There are a number of methods by which the state might encourage this industry, but first and foremost it must so arrange its taxation policy that there is no danger of this new industry's being taxed out of existence. It must be looked upon as a manufacturing industry and taxed as such. One way of doing this would be to abolish the ad valorem tax on all ores containing under 40 per cent of iron, and tax them only by means of the occupational tax, that is, tax only the profit made by treating the low-grade ores. By this method of taxation, the income to the state from the lean ores would never be great as compared to the present income from the high-grade ores, but it would persist for hundreds of years.

This change in taxation policy alone would probably not be sufficient encouragement to start the new industry at the present time. But legislation that would remove the risk and uncertainty of taxation expense would be a very definite assurance to the iron and steel industries of the country that Minnesota appreciated its position and intended to do everything in its power to make its low-grade ores available.

It would be necessary for the mining companies to invest millions of dollars in treatment plants, in opening up new mines, and in experimenting, for a time at least, with new and untried processes which would show no profit for a number of years. This industry should be started now, however, so that it will be strong and well established in ten years, when the end of our high-grade ore is more plainly in sight, and when it has become more definitely necessary for the large steel companies to strengthen their dwindling ore reserves.

These large steel companies, with many hundreds of millions invested in plants and equipment can only make steel if they have iron ore, and it is necessary for them to have many years' supply of ore in advance. They cannot issue 20-year bonds unless they have a 20-year supply of ore, and they are therefore accumulating ore at the present time to be used 20 years hence. Until it is commercially demonstrated that the low-grade material can be economically converted into merchantable ore, these steel companies cannot consider this material as a future ore supply, but must look elsewhere. This is the reason why it is so important for the state to assume a liberal attitude toward the low-grade iron ore industry and do everything in its power in the very near future to assist the mining companies in demonstrating the commercial value of these low-grade materials. We want the steel companies to strengthen their ore reserves in Minnesota and not in Canada, South America, or Africa.

High School at Hibbing, Minn. (Population 15,600)
Built with Taxes on Ore Deposits

To anyone who studies the situation, it is evident that financial encouragement will probably be necessary in order to start this new industry. There is nothing new or radical, however, about this, as Ontario already pays a bonus for mining and beneficiating iron ore within its boundaries. In effect, this would simply be charging the high-grade ore industry a sufficient tax so that for the next few years some of it could be given to operators having sufficient courage to undertake the utilization of the low-grade ores.

There is, of course, a possibility that this low-grade iron ore industry may develop without the aid of a bonus, but it is certainly true that it will not develop properly without some changes in our taxation policy. It is evident that the situation is quite involved and that the remedy requires combined study by the technical, economic, legal, and legislative talent of the state. It is a simple matter for the technical man to propose changes in the laws for the improvement of conditions, but the economist must then decide whether or not the changes are sound and workable, and what their effect will be on the iron mining industry, on the various cities and villages on the iron ranges, and on the state as a whole. The legality of any proposal must be passed upon by legal experts, and the proper bills and amendments must be carefully drawn up to put the plan into complete operation, and at the same time properly to protect all parties concerned. Last and probably most difficult of all, the plan must be brought before the people of the state, presented in the proper political light, and eventually incorporated into law. This looks like a very large order, but when the stakes are considered, it seems that the game is decidedly worth the candle.

Developing the Upper Mississippi

THAT portion of the Mississippi River extending southward from Minneapolis to the mouth of the Illinois River, a distance of 650 miles, has been under improvement by the U.S. Government since 1878, but has still an unsatisfactory 6-ft. channel. By the River and Harbor Act of 1930, Congress adopted a canalization project for this section, to provide a 9-ft. depth throughout. This program calls for the construction of 24 new locks and dams at an estimated cost of $124,000,000. When this work, upon which a start has been made, is completed, a minimum depth of 9 ft. will be available for navigation all the way from St. Paul to the Gulf.

In the symposium which follows, Mr. Hill deals chiefly with the history and economic aspects of Government improvements in the Upper Mississippi; while Mr. Ylvisaker is concerned with the ground-controlled aerial surveys completed under contract by the Corps of Engineers for the purpose of recommending to Congress the most feasible means of providing the required 9-ft. channel.

Both of these articles are abstracts of papers presented at the St. Paul Meeting of the Society—Mr. Hill's before the Technical Session on October 7 and Mr. Ylvisaker's before the meeting of the Surveying and Mapping Division on October 8.

Plans for Deepening Existing Channel

By Hibbert M. Hill

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FOR purposes of identification, the Mississippi River has been divided according to its natural characteristics into three sections, known as the Lower, the Middle, and the Upper Mississippi. The Middle and the Lower Mississippi are commonly regarded as capable of providing a minimum depth of 9 ft. for satisfactory open river navigation, although much work yet remains to be done before such navigation will be assured. The Upper Mississippi, which extends northward from the mouth of the Missouri River for 670 miles to Minneapolis, has now an unsatisfactory channel nominally 6 ft. deep.

By act approved July 3, 1930, Congress adopted a project which, on completion, will provide an adequate channel 9 ft. deep in the Upper Mississippi from Minneapolis to the mouth of the Illinois River, 20 miles above the mouth of the Missouri. Southward from this point, present methods of improvement under existing projects will establish a navigable waterway to the Gulf of at least the dimensions proposed for the upper river. The 650 miles of the Mississippi between Minneapolis and the mouth of the Illinois River constitute the Upper Mississippi Waterway here discussed, and shown in Fig. 1.

Early traffic on the upper river was conducted under conditions which would have discouraged the most sanguine of present-day advocates of the waterway. The channel was crooked, with minimum depths at low water of about 3 ft. In the 200-mile section below St. Paul the depth often approached 1 ft., and the channel was filled with snags and generally unsuited to navigation.

FORMER IMPROVEMENT PROJECTS

In 1878 Congress adopted the first regular project for improvement of the upper river, contemplating a $4^1/_2$-ft. channel depth at low water. In 1907 the project depth was increased to 6 ft. and suitable widths were provided for. Except in certain reaches, the 6-ft. channel was to be obtained by open river methods, that is, by the construction of river training works consisting of wing and closing dams, and by dredging, as indicated in Fig. 2.

In addition to these works in the channel, the United States has maintained and operated since 1884 a system of six reservoirs, shown in Fig. 1, at the headwaters of the Mississippi. This system has a total capacity of about 2,200,000 acre-ft. The principal reservoirs are at a river distance of approximately 400 miles above St. Paul, and the nearest is about 200 miles above. Their greatest effect has been on such traffic as existed between them and St. Paul, principally on lumbering, which is now extinct. In the reach of about 30 miles immediately below Minneapolis and St. Paul, they have aided materially in maintaining navigable depths. But this reach has recently been canalized, so that the reservoir system has now become purely an emergency auxiliary to other methods of improvement.

Under the 6-ft. project, which has been virtually completed, the Upper Mississippi has become perhaps the most completely regulated river in the world. The present channel is a very material improvement over original conditions, but it is still narrow and of deficient depth. The most marked effect of regulation has been to ease the bends and crossings so that tows can follow the channel. Regulation in combination with continuous dredging has increased the depth somewhat. However, in 1931, a year of very low flows, tows drawing $4^1/_2$ and 5 ft. often went aground at various points along the upper river.

So far, the United States has spent, exclusive of the Lock and Dam at Rock Island now under construction and other work now in progress, about $45,000,000 in improving this upper part of the Mississippi River.

In 1927 regular service from St. Louis to Minneapolis was established by the Upper Mississippi Division of the Government-owned Inland Waterways Corporation. Establishment of this service was in response to a sudden revival of interest in water transportation, due principally

to the abolition of certain preferential rail rates enjoyed prior to the Great War by the Upper Mississippi Valley, and particularly by the Twin Cities.

The principal handicap of the Inland Waterways Corporation operating in the Upper Mississippi is the uncertain service it is compelled to offer because of the limitations of the waterway. Those interested have been convinced that commercially successful traffic cannot be developed on a channel less than 9 ft. deep. Hence they had an item inserted in the River and Harbor Act of January 21, 1927, in accordance with which the Chief of Engineers, after preliminary study, on May 29, 1929, appointed a board of officers to survey the Mississippi River from Minneapolis to the Illinois River to determine the best method of securing a channel depth of 9 ft. at low water, with suitable widths. It was on account of the limitations of the existing waterway, amply demonstrated during the present low-water season, when traffic was all but forced to cease, that Congress adopted in 1930 the project for canalization indicated as feasible as a result of this survey.

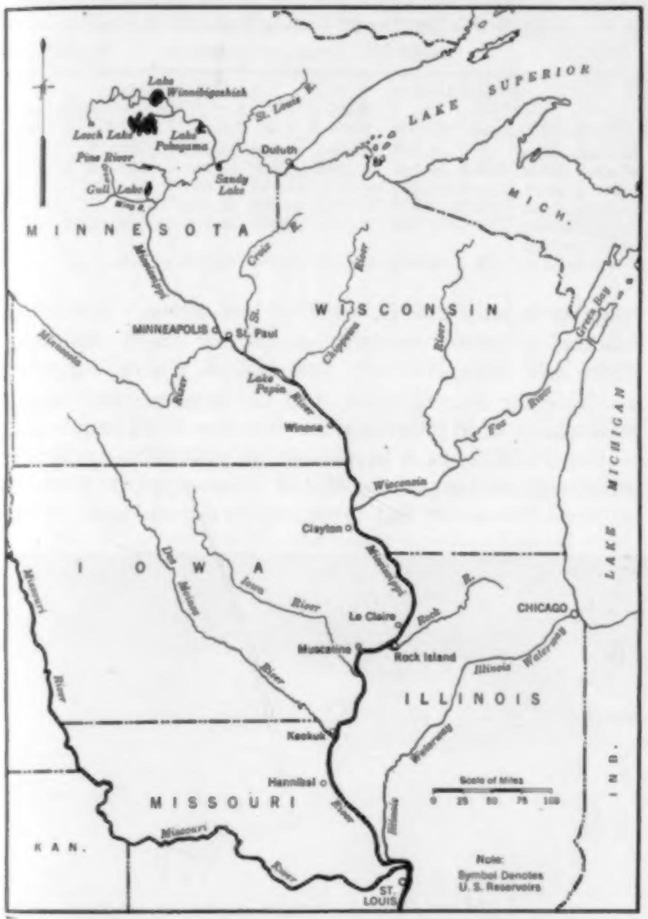


Fig. 1. The Upper Mississippi Watershed

A GREATER STREAM ONCE EXISTED

Immediately above the Illinois River the watershed of the Mississippi contains 143,000 sq. miles of flat or rolling timber and agricultural land. It includes major parts of Minnesota, Iowa, and Wisconsin, as well as smaller portions of Illinois and Missouri. That portion of the basin occupied by the river at flood stages was formed by a far greater stream than now exists, which followed, not the present course of the Mississippi north of Minneapolis but that of the Minnesota River, which flows into the Mississippi from the west at the Twin Cities. The present stream, which has low-water widths of about 500 ft. at the upper end and about 3,000 ft. at the lower, wanders from one side of the valley to the other. Its bed is in sand approximately 100 ft. thick, which overlies the sandstone of the older river bottom. Only at two localities is rock found at utilizable depths, at and above Keokuk and Rock Island. The bottom lands are for the most part densely covered with timber or brush.

Twin Lock Under Construction
At the Twin City Lock and Dam. The Principal Work Is the Excavation of 265,000 Cu. Yd. of Sandstone

Throughout the length of the upper river, and particularly above Muscatine, Iowa, there are numerous cities,

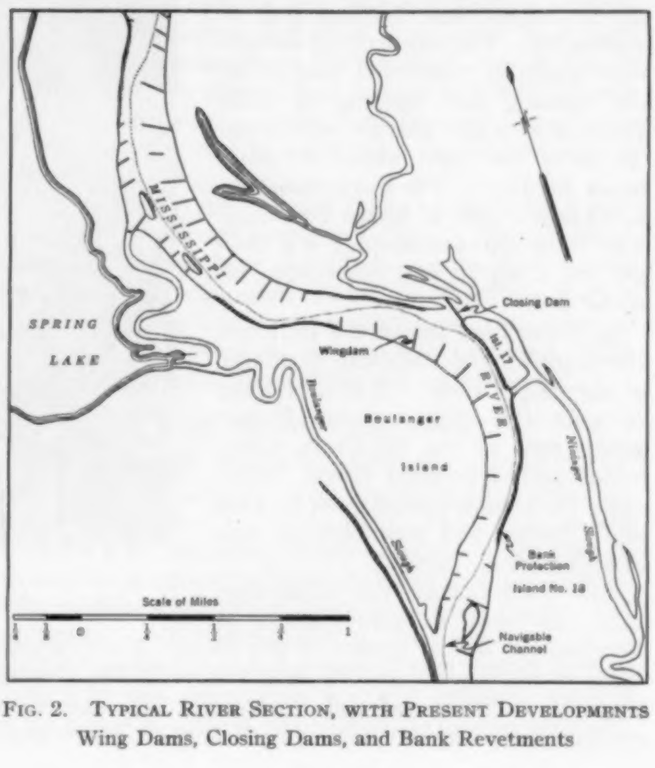
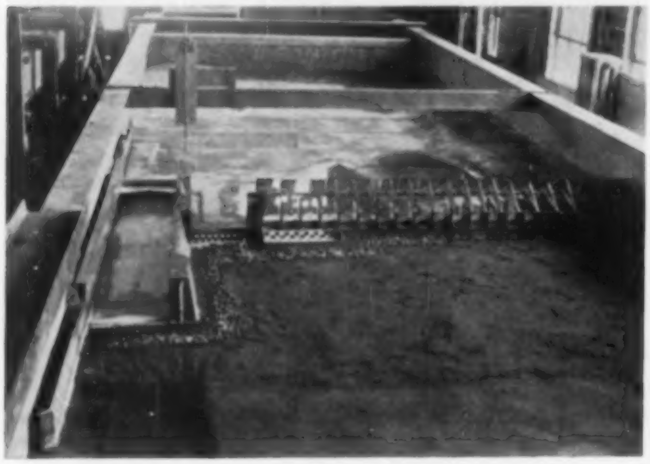


Fig. 2. Typical River Section, with Present Developments
Wing Dams, Closing Dams, and Bank Revetments

highways, railroads, and other structures in the valley at an elevation just above high water. For the 200 miles below St. Paul, railroads parallel the river at the foot of each bluff, and below Muscatine there are many levee districts protecting valuable lands in the valley.

HYDROLOGY OF THE UPPER MISSISSIPPI

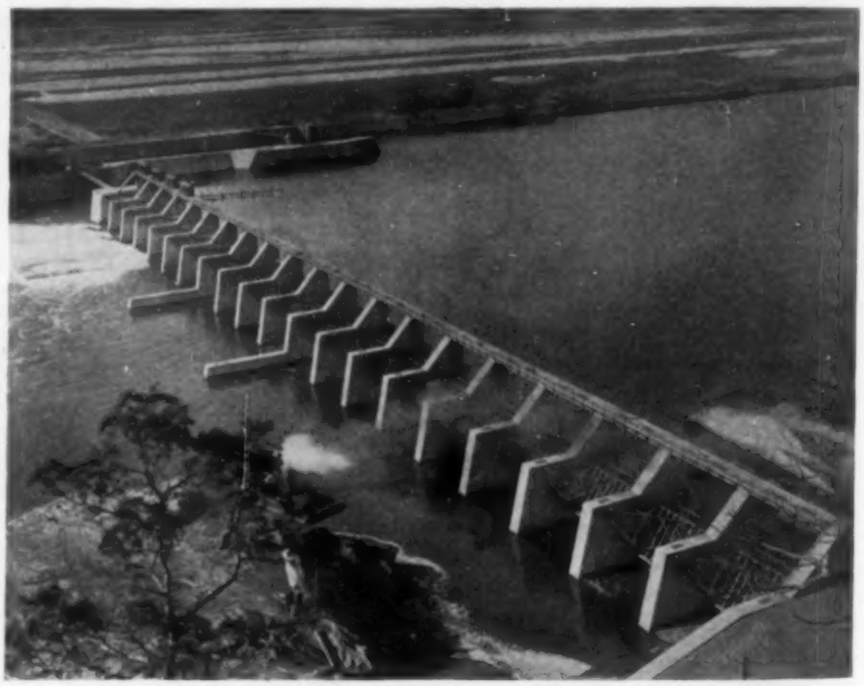
The most marked and important hydrological characteristic of this section is the small range of stage, which



MODEL OF THE HASTINGS LOCK AND DAM
Ready for Testing in the Hydraulic Laboratory of the University of Iowa

nowhere exceeds about 23 ft. between extreme high and extreme low water. High water occurs in the spring and early summer, from the latter part of March to the first part of July. The lowest discharges, which come in January or February, are due to the low temperatures prevailing at that time. During the navigation season, the lowest stages are in August and the first half of September. The length of the navigation season is controlled largely by the opening and freezing of Lake Pepin, a long and narrow lake in the course of the river about 50 miles below St. Paul. The navigation season has a length of about 7 months. The mean dates of opening and closing are April 10 and November 10, respectively.

In Table I are shown the principal characteristics of stage and discharge of the upper river. It is interesting to note the effect on run-off per square mile of the St. Croix, Chippewa, and Wisconsin rivers, which enter the Mississippi between St. Paul and Clayton, and flow from an area of high average rainfall.



HASTINGS LOCK AND DAM
Viewed from the Left Bluff 100 Ft. Below the Crest Line

The total fall of the Mississippi from the head of navigation at Minneapolis to the mouth of the Illinois River, a distance of 646.6 miles, is 318.8 ft. This results in a mean slope of 0.493 ft. per mile. Slopes in the unpooled reaches, excepting the Rock Island Rapids, range from about 0.2 ft. per mile to about 0.6 ft. per mile. The profile to a small scale is shown in Fig. 3.

WING DAMS FIX NAVIGABLE CHANNEL

Except for the comparatively short reaches now canalized, the main channel of the river is delimited by the ends of the wing dams (Fig. 2) which have been constructed to fix its position and to narrow the stream at low water, with a view to deepening it. The distance from the ends of the wing dams to the opposite shore varies from about 600 ft. below St. Paul to about 1,200 ft. near the Illinois River. The navigable channel has widths considerably less than these, however, and frequently is only 200 ft. wide at low water. While this channel is never straight except for short distances, there are comparatively few points where curvature controls the size of tows, and these points are readily susceptible of improvement, or are now being improved.

TABLE I. HYDROLOGICAL DATA FOR UPPER MISSISSIPPI RIVER
April 1 to October 30 During Period of Record

Locality	Miles Below St. Paul	Drainage Area in Sq. Miles	Discharge in Sec-Ft. Maximum	Discharge in Sec-Ft. Minimum	Discharge in Sec-Ft. Mean	Discharge in Sec-Ft. Mean per Sq. Mile	Stages in Ft. Maximum	Stages in Ft. Minimum
St. Paul, Minn.	..	36,780	117,000	2,000	14,400	0.392	19.7	−2.3
Winona, Minn.	115.9	59,100	174,000	8,700	36,000	0.609	16.9	−1.1
Clayton, Iowa	212.0	79,200	226,000	14,700	56,300	0.711	21.3	−0.1
LeClaire, Iowa	347.1	88,400	250,000	17,500	62,600	0.708	14.5	−0.1
Hannibal, Mo.	539.1	137,200	352,000	19,800	86,200	0.628	22.5	−0.2
Above mouth of Illinois	634.2	143,000	364,000	20,100	89,000	0.622	..	..

Depths of from 4 to $4^1/_2$ ft. at controlling points in nearly all sections of the Upper Mississippi are found at extreme low water, but these depths depend upon dredging. In extremely dry seasons, such as that of 1931, it has not been possible with the available facilities to keep all the crossings dredged. It must be said, however, that even the most liberal supply of equipment would not

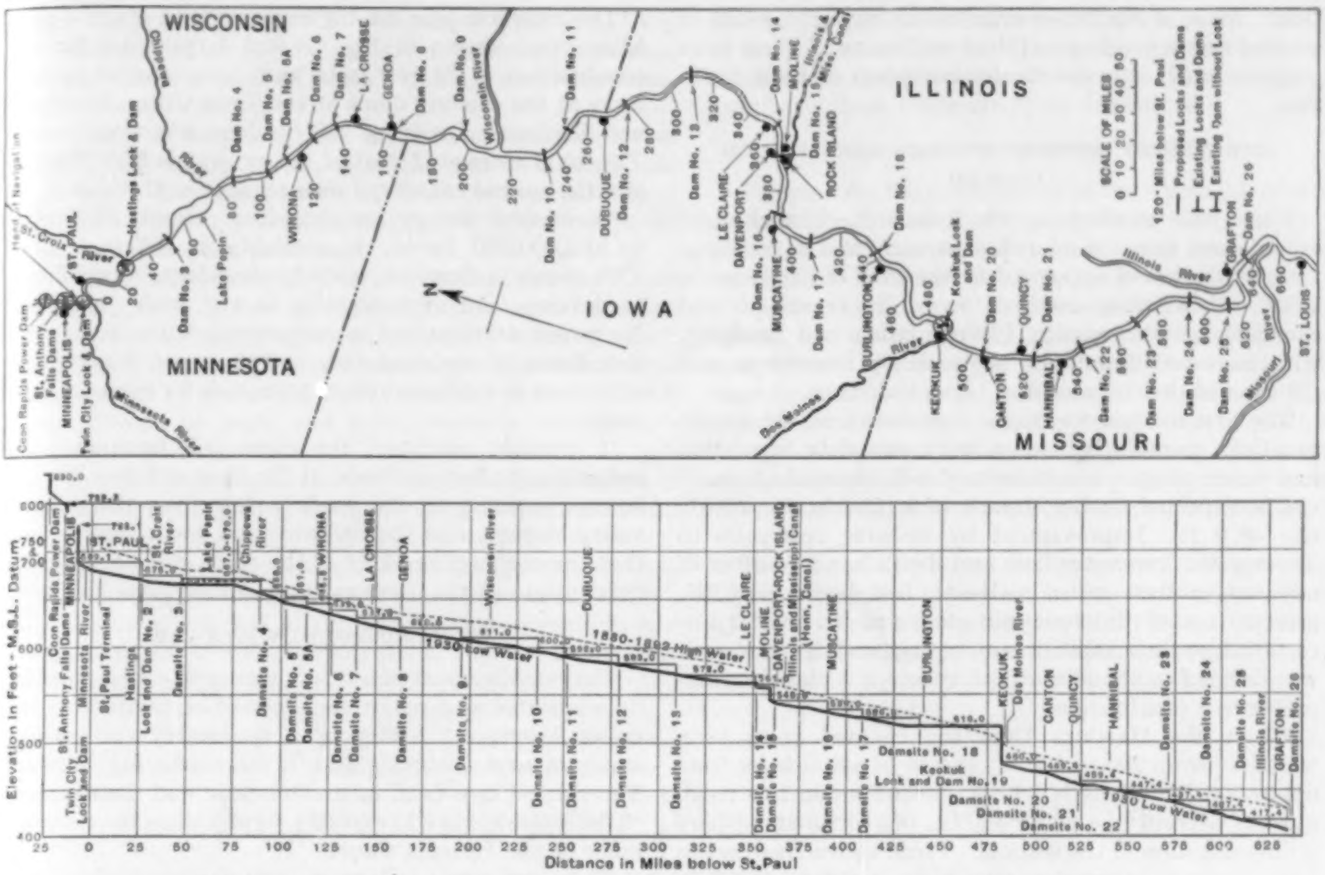


FIG. 3. CONDENSED PROJECT PLAN AND PROFILE FROM MINNEAPOLIS TO THE ILLINOIS RIVER
Showing 9-Ft. Channel Project on the Mississippi River

have made it possible to maintain a 6-ft. channel this year.

At the foot of Lake Pepin, the Chippewa River enters from the left, with an average discharge of 7,500 sec-ft. This river in its lower reaches has a slope of about 1.8 ft. per mile, and a consequent high velocity. The large quantities of sand which it carries are deposited at its mouth, backing up the Mississippi, and forming Lake Pepin immediately above. This situation has caused a very difficult maintenance problem. For about 10 miles below the Chippewa River it has been impossible to maintain a low-water channel more than about 5 ft. deep.

ROCK ISLAND RAPIDS SERIOUS OBSTRUCTION

The worst existing obstruction to navigation in the upper river is the Le Claire-Rock Island Rapids, 13.7 miles in extent, which have a total fall of about 20 ft. over a limestone formation. They present a very difficult problem in that they are partly within the limits of the Tri-Cities—Rock Island, Davenport, and Moline—so that their improvement is complicated by existing sewers, hydro-electric plants, and other structures.

Of the section below Rock Island, 80 miles are pooled by the Keokuk Power Dam, containing a single lock with a lift of 41 ft. This was built in 1910 at the foot of the Des Moines Rapids, which prior to that time presented a hazard similar to the Rock Island Rapids. In Lake Keokuk the channel has ample depth and width but is somewhat hazardous because the standing timber was cleared from the pool only along the channel line, and now is a source of danger when there is any deviation from the channel proper. The size of this lake is such that storms also present a hazard, particularly at many points where the standing timber makes it impossible to reach shelter near shore.

There are 46 railroad and highway bridges crossing the Upper Mississippi, but all of them either have sufficient vertical clearance for the towboats now in use, or are movable. In general they present but little impediment to navigation. Some few, however, have very narrow openings, and in a few cases the channel span is awkwardly placed.

In summary, it may be said that at present the Upper Mississippi Waterway provides a channel through which in normal seasons it is possible to operate tows having approximate dimensions of 600 by 100 ft., with a draft of about 5 ft., and a load of about 4,000 tons. In abnormal seasons smaller tows, on a somewhat reduced draft, have great difficulty throughout the waterway.

RIVER TERMINAL FACILITIES

With the recent establishment of the Inland Waterways service on the upper river, the question of terminals has received particular consideration. Since 1927 modern terminals with unloading facilities and direct rail connections for package and bulk freight have been constructed at Minneapolis, St. Paul, Dubuque, Rock Island, and Burlington. Minneapolis and St. Paul also have facilities for handling coal and grain. These terminals were all built by the communities involved and receive rental on a tonnage basis from the Inland Waterways Corpora-

tion. Most of the larger river towns have some sort of loading and unloading facilities, and many of them have projects under way for the improvement of these facilities.

IMPROVEMENT METHODS STUDIED—CANALIZATION ADOPTED

Three basic methods by which the 9-ft. channel might be obtained were considered, separately and in combination, by the board appointed by the chief of Engineers in 1929. These three methods were: (1) regulation and dredging, as at present; (2) regulation and dredging, with increased flow to be provided by reservoirs; and (3) canalization by means of locks and dams.

The first method was early abandoned, on the purely practical ground that, since very complete regulation had failed to give a satisfactory 6-ft. channel, it could not be expected, in the absence of a miracle, to provide one of 9 ft. Improvement by utilizing reservoirs to increase the low-water flow and depth has a number of advantages over other methods, but because of the greater cost of the reservoir plan and its greater uncertainties—uncertainties both of cost and operation—it was decided to abandon it and to adopt a plan for comprehensive canalization.

Above the Hastings Dam the channel is to have widths of from 200 to 800 ft., and to be suitable for tows up to 700 ft. in length. Lock dimensions in this reach must of necessity be 56 by 400 ft., but fortunately there is only one dam in the section. From above Hastings to Lake Keokuk, channel widths of from 300 to 1,600 ft. are contemplated, suitable for tow lengths up to 700 ft.; and from Lake Keokuk to the Missouri River, channel widths of from 500 to 2,000 ft. are to be suitable for tows up to 1,000 ft. in length. The lock at Hastings, planned prior to the adoption of the 9-ft. project, is 500 ft. long. From Hastings south all locks are to have a width of 110 ft., and the main locks are to be at least 600 ft. long.

At the Twin Cities, Rock Island, and Keokuk, where the dams are comparatively high and there is no provision for passing navigation through them in case a lock is not usable from any cause, an auxiliary lock 110 ft. wide and at least 360 ft. long is regarded as essential. In other cases provision for emergency passage is provided.

TYPE OF DAM TO BE USED

It is evident that the dams used must be of a type to cause as little constriction of the stream as reasonably possible. The selected type therefore provides large gates, probably of the roller type and about 100 ft. wide, in the deepest part of the channel, with 30-ft. Taintor gates in the shallower parts to make up the remainder of the discharge area. Both the large gates and the Taintor gates will have their sills substantially at streambed elevation. The structure will be completed by an earth dam of pumped river-bottom material, principally fine sand, faced with riprap on the upstream face and elsewhere when required, and provided with steel sheetpile core walls as needed. These earth dams will in many cases be from one to two miles long, but will generally not sustain much head. They will have maximum heights of about 30 ft. at crossings of sloughs, and average heights of from 10 to 15 feet., including the necessary freeboard.

The complete plan for the improvement of the Upper Mississippi, shown in Figs. 3 and 4, provides for the construction of 24 new locks and dams, and of parallel locks at the existing dams at the Twin Cities, Hastings, and Keokuk. Dredging will be done where necessary. The total estimated cost of the project is $124,000,000 and the annual calculated maintenance is $1,750,000.

Theoretical energy ranging from about 20,000,000 to 400,000,000 kw-hr. is available at different sites. This energy is, however, entirely secondary, very difficult to develop, and unmarketable in any such quantities. No power development in conjunction with the navigation dams is contemplated, and it is not feasible, by utilization of a different plan, to provide for such development.

If properly operated, the dams will have only an insignificant effect on floods, at the dams or below, for the storage capacity of the pools is less than the natural valley storage, and the spillways are to be designed so that the contracting effect of the dams will not increase flood stages at the dams more than about one half foot.

ECONOMICS OF THE WATERWAY

The establishment of a 9-ft. channel is looked upon by its advocates as a major step toward restoration to the upper Mississippi Valley of a reasonably competitive status in manufacturing and in the marketing of grain. The competitive field, in manufacture and distribution, of the interior cities has greatly shrunk since the development of the Panama Canal.

There are now, and have been for some time, two principal outlets for grain from the Northwest destined for export or consumption in the East—one through Duluth by lake and railroad, and the other through Minneapolis by rail alone. Since the war, the equalization of rail and water rates through these two markets has been abandoned, and Duluth now enjoys an advantage over Minneapolis of approximately 13 cents per 100 lb. The result is that competition between the two markets is largely what Duluth desires to make it, and the premiums formerly arising from competition have disappeared.

If, as appears probable, the proposed development of the Upper Mississippi can restore the competition between Duluth and Minneapolis, a very substantial benefit to the grain producers will accrue. It has been testified that an equalization of rates through the two markets would raise the value of all grain produced in the area, approximately one billion bushels annually, by from 5 to 15 cents per bushel. This benefit alone, if realized, would amply justify the cost of the waterway.

The effect of the present rate adjustments has caused a great decline in the milling of flour in the Northwest, and has displaced Minneapolis from its former preeminent position in this industry. Other industries have suffered similarly. If, as anticipated by its advocates, the Upper Mississippi Waterway will restore previous conditions in these fields, a material benefit, possibly alone sufficient to justify the waterway, would be realized.

According to the best data now available, a large tonnage of materials suited in some degree to transportation over the Upper Mississippi is now shipped into and out of an area which can reasonably be considered eco-

nomically tributary to this waterway. This area, lying to the west of the Mississippi River, includes Minnesota, North Dakota, most of South Dakota, part of Montana, and part of Iowa.

The total weight of these inbound commodities is over 22,710,000 tons per year, of which over 14,000,000 tons are coal. Outbound commodities in the same class total 9,060,000 tons per year, of which 8,400,000 tons consist of grain and grain products.

One detailed analysis of these data indicates that there would probably be an upbound movement over an improved waterway of about 15,500,000 tons, of which 8,000,000 tons would be coal; and a probable downbound movement of about 4,950,000 tons, of which 4,500,000 tons would be grain and grain products, and the remainder iron ore.

If the barge rates on coal and grain, exclusive of terminal and handling charges, varied between 1.25 and 2.0 mills per ton mile, and somewhat higher rates prevailed for other commodities, these tonnages would result in an annual saving over present rail rates of $12,722,000, exclusive of the cost of the construction, operation, and maintenance of the waterway itself. On the basis of the estimated annual costs of construction, operation, and maintenance, this saving represents about $11,000,000, or 8.9 per cent of the initial cost, to be applied annually to the items of depreciation, interest, and taxes, on whatever basis these items are to be considered.

PRESENT STATUS OF THE PROJECT

The plan for the canalization of the Upper Mississippi, essentially as outlined, was adopted by Congress in the River and Harbor Act of July 3, 1930, and an initial expenditure of about $13,500,000 was authorized. At the present time the works contemplated above Hastings, Minn., are all under way and are scheduled for early completion. The lock and dam at Rock Island is under construction and work on the lock and dam at Alma, Wis., is to be started during the coming winter. Completion of these works will greatly improve the present channel by eliminating several of its weakest points, and will also practically exhaust the sum authorized for the waterway.

There is great interest in the project throughout the Upper Mississippi Valley. Concerted efforts are planned by those interested to obtain from the next Congress not only the necessary appropriation for the project, but also assurance of its completion within a short period.

Surveying and Mapping Methods

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ON MAY 29, 1929, the Chief of Engineers, U.S. Army, appointed a special board of officers to investigate and report on a plan to provide 9-ft. navigation on the Mississippi River from its confluence with the Missouri River to Minneapolis. The Upper Mississippi River had previously been mapped by the Mississippi River Commission, from 1882 to 1901, and the map was published on a scale of 1:20,000 with a contour interval of 5 ft. The horizontal reference plane was Memphis datum, approximately 7 ft. below mean sea level. As this map was considerably out of date and it was desirable, in order to coordinate the proposed Mississippi improvements with other river projects, to refer all work to mean sea level, the board decided to resurvey the river.

THREE IMPROVEMENT METHODS STUDIED

Three alternate plans of river improvement were possible—canalization by locks and dams, regulation by dikes and revetment, and storage in reservoirs to increase the low-water flow. Combinations of these methods were also considered. To study the regulation and reservoir methods, only detailed surveys of the river channel proper were needed, but to fully plan a canalization project required detailed topographic surveys in order to locate the proposed dams and estimate the inundated areas. Existing maps, mainly U.S. Geological Survey quadrangles, and field reconnaissances were sufficient to determine reservoir capacities on the tributary streams.

Since it was impossible to determine definitely the best type of improvement without accurate survey data, and since the character of the survey depended directly on the type of improvement proposed, the decision as to the scope and character of the surveys was a perplexing matter. However, from Keokuk Dam downstream the hydraulic characteristics of the river indicated the likelihood of effecting the improvement by regulating works, and from Keokuk upstream, past experience made canalization appear feasible.

Since the efficacy of river improvement by regulation depends directly upon the relation between the low-water flow, the slope, and the channel cross section, it was logical to investigate first the effect of regulation on the section of the river farthest downstream, where the low-water flow is at a maximum. If the desired channel could not be obtained in the lowest section it certainly could not be obtained farther upstream. It was decided therefore to confine the first study of the possibility of regulation to the section from the mouth of the Illinois River to Keokuk Dam, a distance of 152 river miles, and to limit the initial survey in that section to a line map with no contours.

CANALIZATION INVESTIGATED

Canalization was known to be a feasible method, the adoption of which was limited only by economic considerations. It was necessary that this type of improvement be thoroughly investigated. The board therefore determined to study the feasibility of a canalization scheme

in the middle section of the river, from the upstream limit of the pool of Keokuk Dam to the upper limit of the Rock Island Rapids, a distance of 135 miles. Accordingly a topographic map with contours was fixed upon for that section.

It was decided to limit the survey for the remainder, or upper section of the river to a line map without contours, of the same type as that for the lower section. Such a map would serve as a basis for planning a method of river regulation with or without reservoir storage, and could be easily adapted to a canalization project at small cost by adding contours, thus making it similar to the map of the middle section.

In short, the board determined upon an economical surveying plan which permitted all three of the proposed projects to be thoroughly investigated and was sufficiently elastic so that it could be rapidly and economically changed to a complete contoured map, should later studies require.

Because of the magnitude of the projects under consideration, it was important that the surveys on which the plan would be based should be broad in scope and of such character as to serve as a permanent basis for the actual construction of the project adopted.

With all indications pointing to a canalization plan for at least the upper section of the river, the question arose as to whether the basic survey should furnish a large-scale map with a small contour interval, on which all details of dam sites and individual tracts of overflowed land could be plotted; or a smaller-scale map with a larger contour interval, to show the general outline of the improvement, and to be supplemented by additional detailed surveys for sites and flowage.

After a study of this problem, the scale of the basic map was fixed at 1,000 ft. = 1 in., requiring in the middle section a contoured map with a contour interval of 5 ft.

In securing the finished map, the time element was a controlling factor. Experienced personnel was not available in the engineer districts concerned and the organization and training of the men required would have been a long and costly procedure. The board, therefore, decided to prepare specifications and have the work done by contract.

SURVEY SPECIFICATIONS WERE FLEXIBLE

According to the main provisions of the specifications as issued, the area to be surveyed covered all land to an elevation of 10 ft. above extreme high water, except when that limit was farther than two miles distant from the normal water's edge on either side of the river, in which case the two-mile limit controlled. Bids were asked on three separate items, conforming to the general program described previously, as follows:

1. A contoured map, including a controlled aerial mosaic, for the area from Burlington, Iowa, to the head of the Rock Island Rapids, a river distance of 100 miles, with a total area of 261 sq. miles.

2. A line map without contours of the remainder of

FIG. 1. PORTION OF A TYPICAL CHART, UPPER MISSISSIPPI CONTRACT SURVEY BY AERIAL METHODS
Culture, Indicated on Original Charts by Colors, Here Shown by Shaded Areas

the area from the mouth of the Illinois to Minneapolis, a river distance of 514 miles, with a total area of 1,227 sq. miles.

3. The placing of contours on the line map required under the second item. This item was included to provide the desired flexibility in adapting the survey to the progress of the board's studies in making a preliminary determination of the best type of improvement.

Alternate bids were invited on the second item, one by the aid of aerial photography, and one by ground methods only, with the thought that the existing map of the Mississippi River Commission could be corrected and brought up to date without the use of photography. Preference was given to aerial photographic methods, at a rate of $5 per sq. mile.

In canvassing bids, the time proposed by the bidders for the completion of the work was considered at the rate of $37.50 per day for each of the first two items, and $75 per day for the first two, or all three items combined. Liquidated damages equal to these sums were prescribed for delay. Proposals for more than 320 days were not considered.

Payments were based on a square-mile unit as actually planimetered on the finished sheets. If aerial photography were used, a rough or uncontrolled mosaic would be accepted as a basis for partial monthly payments at the rate of 15 per cent of the total price bid. Additional monthly payments would be made as fast as the finished sheets were delivered and accepted.

DETAILED REQUIREMENTS FOR THE MAP SHEETS

Detailed requirements as to the accuracy and presentation of the map sheets were stated in the specifications as follows:

"*Map Sheets.* Map sheets shall be prepared on a polyconic projection at a scale of 1:12,000, on sheets 27 by 40 in. outside dimensions, and shall include an index sheet to a suitable scale. The horizontal positions of all features shall be shown on North American datum and all elevations referred to mean Gulf level. Contours shall be shown with an interval of 5 ft. and shall be of such accuracy that when careful profile lines are run in the field by the contracting officer between definite points located on the map and identified on the ground, at least 90 per centum of test points determined by the profile lines shall not be in error on the map more than one half of the contour interval. These test lines will be made by the contracting officer at his discretion, but must be made within 30 days of the delivery of the map sheets.

"Cultural features to be shown on the map shall include roads, railroads, residences and large buildings, shore lines, the nature of the ground (cultivated, wooded), bridges, bench marks, all permanently monumented transit stations, and all other data appearing on the photographs which can be clearly represented on the map scale. All features shown on the maps shall be located with such accuracy that no error is measurable to the scale of the map. Elevations of artificial features affecting stream flow, such as levees, railroads, highways, bridges, and permanent dams, shall be determined by ground levels and shall be accurate to within one half foot in elevation.

"Sounding ranges shall be shown at intervals of one half mile. Soundings shall be made 100 ft. apart across the entire width of the river and shall appear in horizontal location on the map as accurately as the scale of the map will permit. Soundings shall be shown in elevation above Gulf level, and shall represent the bed of the river to the same degree of accuracy required for contouring under Par. 12-d.

"Copies of all field notes and necessary computations to establish positions and elevations shall be submitted to the contracting officer.

"Projection lines shall be shown at intervals of one minute of latitude and longitude. The central meridian of each sheet shall be parallel to one edge of the sheet, with the top of the sheet facing either north or west.

"The completed map sheets shall be furnished in four colors: brown for contours, black for culture, blue for drainage, and green overprint for wooded areas. The map assembly shall be a finished drawing in these colors, including all lettering, and suitable for final photo-lithography, and shall be compiled on metal mounted sheets, to be furnished by the contracting officer. Standard topographic symbols as published in the War Department Training Regulations No. 190-10 shall be used, and all lettering shall be placed on the sheets in size and type to be approved by the contracting officer."

Bids were opened September 9. Six bidders submitted bids, and W. N. Brown, Inc., was awarded the contract. The contract price was $153.35 a sq. mile for item No. 1, the contoured area; $80.50 a sq. mile for the line map; and $75 per sq. mile for adding the contours to the line map. Work was begun on October 22, 1929.

Soon after the work had commenced, the contoured map was extended upstream the entire distance to Minneapolis. The complete survey, therefore, consisted of 261 sq. miles of contoured map and 1,227 sq. miles of line map. The contract was terminated December 1, 1930, a total period of 390 calendar days being required for its execution. The total expenditures of the U.S. Government, exclusive of inspection and overhead, were about $200,000. Much of the work was performed during the winter months under severe weather conditions. One successful feature of the winter work was sounding through the ice, using ice augers to drill holes for the sounding lines.

Aerial photography was utilized by the contractor as a basis for all mapping. Cultural features were transferred from the photograph to field boards, and topography was sketched in the field by the plane-table method. The triangulation stations along the river, established by the Mississippi River Commission, were used for primary horizontal control. Plane-table triangulation and transit traverse were used by the contractor for secondary control. The Mississippi River Commission bench marks were used for vertical control. A typical chart for the contract survey is shown in Fig. 1.

A significant fact developed was the inability of the contractor to economically utilize the charts of the former survey in reducing the amount of field work. Changes in artificial and natural features in many localities precluded the use of the former survey without making detailed field sheets for the revision of the old maps, a procedure which would have been more costly than a complete resurvey.

In checking the contract maps, the plane-table traverses for obtaining profiles were run with as little loss

of time as possible. On each sheet, the initial orientation of the plane table was usually made on a highway or railroad tangent. After the table was oriented, the magnetic azimuth line was drawn on the sheet, and the alidade compass was used for orienting for the remaining set-ups on the sheet. This method proved quite satisfactory. The profiles were usually between one and two miles long.

The visible areas on both sides of the traverse lines were tested by obtaining elevations on prominent topographic features. These elevations were given by the second rodman. They were considered together with the profiles in determining the general accuracy of the mapping. Positions of cultural features along the traverse were also checked in this manner. After acceptance, the field sheets, two of which made up one finished map sheet, were transferred to the hard copy and inked in. The finished sheets were again subjected to a careful office check by the contracting officer. On the whole, the results of the survey were excellent from the standpoints of accuracy, expression, and appearance.

ENGINEER DEPARTMENT MAKES SITE SURVEYS

Proceeding simultaneously with the contract survey were the supplementary surveys performed with Government forces. In all, site surveys for 19 locks and dams were completed; wash and core borings were made at each site; temporary river gages were established which, together with the permanent gages already in existence, provided for flow measurement at intervals of approximately 9 miles throughout the entire length of the river; discharge measurements were taken at each site (in which work the U.S. Geological Survey cooperated); and a detailed low-water survey was made of the section from Quincy, Ill., to Grafton, Ill.

Site surveys for the proposed lock and dam at the foot of Rock Island Rapids deserve special mention. From the standpoint of navigation, the work in this section is the most critical of any in the entire river. Since the communities there are highly developed and border directly on the river bank, the determination of the proper pool elevation narrowed down to a matter of a foot or less. This condition made it necessary to survey both sides of the river for a distance of about 14 miles, on a scale of 200 ft. = 1 in., with a 2-ft. contour interval. Practically the entire area was included in a municipal and industrial region, consisting of portions of the cities of Davenport and Bettendorf, Iowa, and Moline and East Moline, Ill. Basement elevations of all buildings adjacent to the river were recorded, and the elevation, size, and slope of all sewers (a total of 59) emptying into the river were obtained by field measurements (Fig. 2).

VALUABLE DATA AVAILABLE TO THE PUBLIC

A review of the accomplishments of the surveys as a whole shows that a vast amount of topographical, geological, and hydraulic data was accumulated and plotted. It is a noteworthy undertaking and is by no means completed. With the adoption by Congress of the canalization project, flowage surveys based on the contract map have been started, and the lower section of the river, for which only the line map was obtained under the contract, is being contoured. Completion of this work will make available for distribution to the public a modern and accurate map of the entire Upper Mississippi, covering a distance of more than 600 miles and an area of 1,500 sq. miles.

The personnel of the board at the time its first report was submitted, on December 16, 1929, consisted of Col. George R. Spalding, Col. Wildurr Willing, Maj. John C. Gotwals, Assoc. M. Am. Soc. C.E., and W. H. McAlpine, M. Am. Soc. C.E., Head Engineer. The District Engineer, Rock Island District, Maj. C. L. Hall, M. Am. Soc. C.E., was the contract officer and had direct charge of the contract work for the War Department. The specifications for the survey were prepared by me.

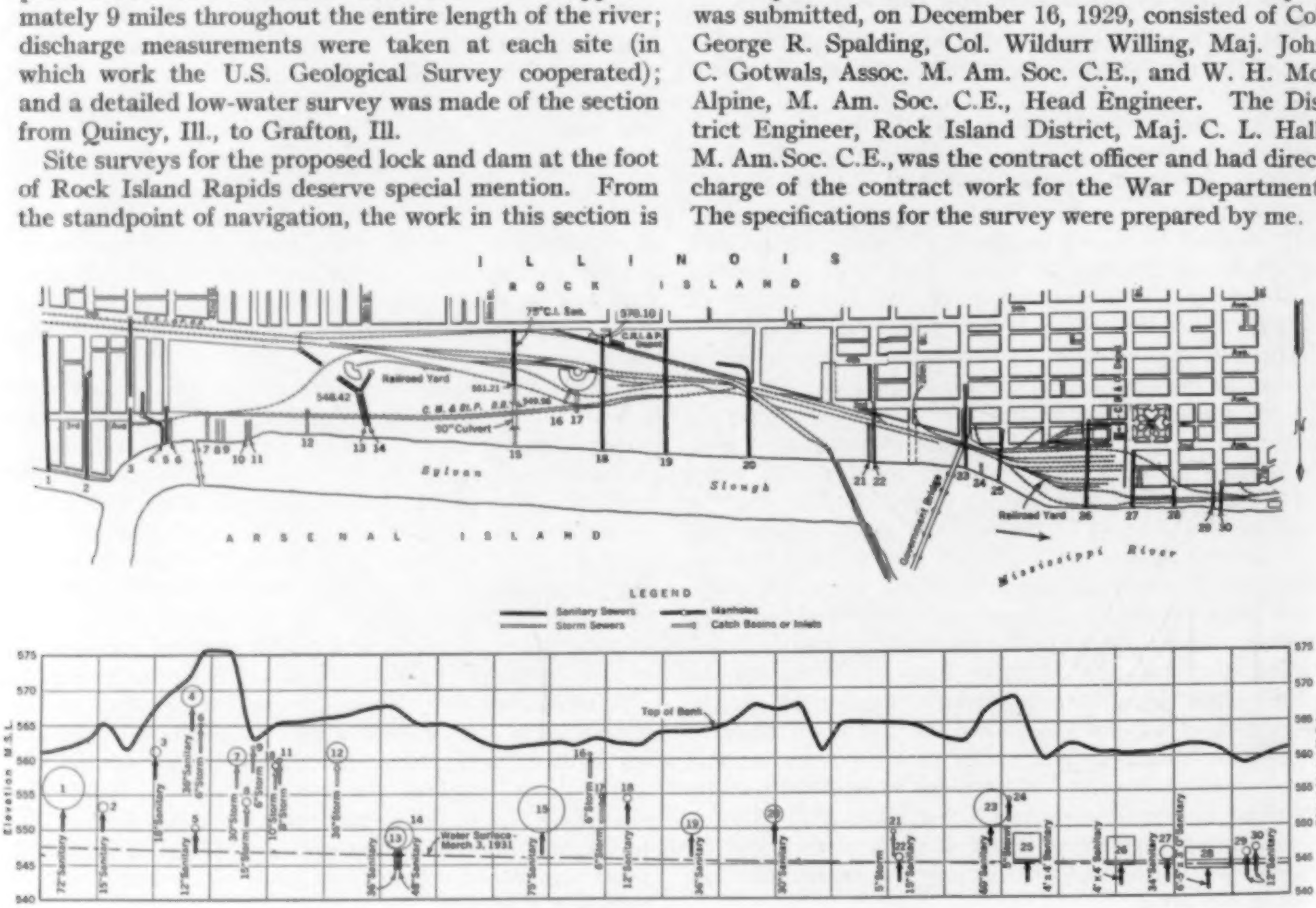

FIG. 2. PLAN AND PROFILE OF SEWER OUTFALLS AT ROCK ISLAND, ILL.
Survey by U.S. Corps of Engineers

The New Competition and New Horizons in Engineering

Glimpsing Undeveloped Fields and Modern Demands of the Profession

By Frederick H. McDonald

Member American Society of Civil Engineers
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NOT often do engineers pause to give to the profession at large an introspective study. In this paper, Mr. McDonald calls attention to the many recent changes in engineering and business which give new outlooks to the civil engineer. Whether the engineer realizes it or not, his environment has undergone a transformation. Can he adjust himself to the new demands? Either he will take a leaf out of the book of industrial progress or he will be outdistanced by his competitors. This paper is a challenge to the profession to examine itself frankly and awake to a larger opportunity for service and success. It has been abstracted from a more extended treatment presented before the first session of the new Engineering-Economics and Finance Division, at the St. Paul Meeting of the Society on October 9, 1931.

THE predominating theme of present-day business discussion can be summarized pointedly in the word "competition." In today's engineering practice there are recognizable the effects of this same affliction, with the unwelcome prospect of a gradual shrinkage, if not an actual crumbling, of the practice of independent, professional engineering. Yet among engineers there appears to be little tendency for any discussion of this competition, what its trend might be, how to meet it, and how to benefit from it, or in spite of it.

Originally the civil engineer was frequently a practicing railroad engineer. Today, aside from the engineering departments of railway organizations, there is little railroad engineering practice. Highway and bridge engineering are passing rapidly entirely into the hands of state, county, and municipal authorities. The same is largely becoming true of engineering for streets, paving, sewers, water supply, and other public works. We also find that most of the large power corporations; the paper, rubber, steel, and other large companies, have their own operating or plant-design engineering departments. This marked tendency of the times for corporations and governmental agencies to develop their own regularly employed technical services is creating a tremendous problem in the gradual restriction of the field of private engineering practice.

A CHANGING PROFESSION

From the standpoint of the total employment of engineers, this tendency is probably developing more extensive and more stable employment of technically trained individuals than previously. But it is also withdrawing from independent practice so great a number of engineers capable of acting as principals as seriously to threaten the unbiased status so necessary to maintain a really independent and professional viewpoint.

One of the greatest assets of the professional man is that clear, disinterested viewpoint enabling him to regard a problem from the detached, unbiased angle of the complete outsider, under conditions where his compensation and the ability to continue in practice are not dependent on his conclusions in any one case. Thus the serious restriction of the field of possible practice is producing an excluding form of competition that, unless met by the professional engineer, is not only menacing his very existence but also is threatening to deprive society, government, and business of his much needed advisory functions.

Almost as excluding is the form of engineering competition which includes in the selling price a complete engineering service that not only looks after the delivery of the unit sold but most often includes all the auxiliary service involved in application. The manufacturer of house radiators, for instance, will design a complete heating system from the boiler up. I do not know that this tendency is subject to any particular criticism, either as a method of doing business or because of its infringement on professional engineering practice. It is simply one of the modern tools the business man is using to advance his business. While the practicing engineer has to combat it, oddly enough it points, itself, to one of the surest ways for him to advance the use of his own particular function—as part of a larger, over-all service he himself can render.

NEW PROBLEMS PRESENTED

Recognizing the existence of this competition, what are we, as engineers, doing about it? Big business has not halted because of competition; rather, competition has made big business. Are we engineers any the less business men? Because we are labeled as a profession, do we have to shut our eyes to the tenets of good business procedure? Or can we analyze the scope of our activities as a field of business; establish its trends and its difficulties; and use its currents and tides to avoid the gales and to get us through the calms?

COMPARISON WITH BUSINESS

In the intense analysis of his market possibilities, the producer first finds some index as to what to make, how it should be made, how much to make, where to sell it, and what his gross and net income from such sales should be. Specifically also, he finds out similar details regarding other commodities and, above all, what he must do to overcome the competitive advantages they appear to offer. The question of specific competition can be left to the individual producer. His is the prob-

lem of marketing his own commodity as against fair competition. The competition from substitutes, from other types of producers, and the unfair competition of similar types of producers, bring about a group defense, which also can become an army of offense, that is very prevalent in the shape of recognized trade associations and institutes.

As engineers, how much thought, time, and effort have we given, as a group, to planned professional advance? In our Founder Societies we have a number of professional associations, already under way, well staffed with an able, selected, and qualified membership; and well financed to do certain types of work. Already, some of the typical functions of the trade associations—the raising of standards and the correction of unfair practices within the profession itself—are ably handled. But almost without exception, are not these practically the only basic functions so far carried out by our societies?

UNTRIED FIELDS

What about studies for new markets; new applications; new fields of practice; and, more important, studies of present changes and trends in the market for engineering services? Is the type of service expected of the engineer today the same as it was a generation, or two generations, or a century ago? Or are the fields, the types of users and clients, and the quality and breadth of expected service all changing?

Oddly enough, success is not so much a product of adherence to previously tried-out and proven fundamentals—in spite of our copy-book maxims—as it is the result of the careful adaptation of the needs of the period to the conduct of one's own business. We have seen the needs of society kaleidoscopically change. Should we, or can we, change our attitude toward, and our service to meet, these needs with some profit to ourselves and our profession and with a greater service to society?

Apart from the usual, what might be called "commodity," services of design and supervision that commonly are required of engineers, what about services that are not demanded of the engineer, but which the engineer can and should supply with benefit to himself and to his client? Are there any undeveloped markets not yet, or at best only partially, labeled as the engineer's? May there not be wide fields of application not now being cultivated, for which the engineer may not now actually be fully prepared himself? Other lines of profitable activity—such as the radio, the automobile, and the electric refrigerator—have glimpsed potential markets, met them, and captured them.

Of engineering, let us say that design and construction are the usual services required. But what of the many phases that every new engineering project has to go through before the physical structure itself becomes even a definitely designable entity? Might it not be that the engineer too long has been a designer of physical structures only? Why not become also a designer, or adviser, or counselor of the structure of whole enterprises? For after all, the structure is but a tool, and frequently one of many tools, for the prosecution of some activity of which it is only an essential element.

For each new project, someone has first to recognize the need or use. How often is that person an engineer? After the conception stage comes the analysis of possible means and ways of accomplishment, with the final selection of some single, apparently best, acceptable means. Then comes the business side—bankers' investigations, promoters' reports, financial analyses and set-ups, and corporate organization. After all this activity, usually without the engineer, comes the actual development stage, with design and construction, followed by use and management. There is not a single phase from conception through use, where the engineer cannot ably fit himself to function with profit if he will but train himself to meet and cultivate these opportunities.

Can engineers prepare themselves to do these things? It is not illogical, for every single one of these factors is based primarily in some way on a physical structure or piece of equipment designed by an engineer.

THE FINANCIAL TEST

Is there business for the engineer in these or allied fields? Whether there may or may not be, who is trying to find this out for the engineer? Can a finger, today, be put on any single agency earnestly capitalizing even a little of the boasted analytical skill of the engineer in an effort to find out where he is, what society and competition are doing to him, and where he might be heading tomorrow if he did certain things, even unrelated to pure science, that reason might show to be helpful?

As a matter of fact, whether he realizes it or not, the engineer of today is in truth a practicing economist, and but very little of that much abused term "scientist." Engineering differs from science in that it is concerned with the proper balance between cost, use, and other derivable benefits; whereas pure science is concerned only with the derivation of effects and results, without particular regard to cost or practicable application. It may be said, then, that engineering is the creation of mediums of purchaseable usefulness, in that the structures or methods it creates must stand the very acid test of economic use and justifiable cost—or not be brought into existence.

These creations, from the standpoint of the engineer, may be any physical evidence of the progress of mankind. Primarily, however, they must be, in common parlance, "worth the money"—or not be built. They must stand the test of investment analysis. When it is considered that money of itself is but the accumulated evidence of conserved production over and above daily needs, and that it must be turned into something useful, something producing benefit or income, before it can be termed wealth, we realize that, aside from the necessary consumable commodities of life, all wealth is in the form of permanent and physical structures—that should be designed and measured for economic value by the engineer.

CREATING WEALTH

We may say then that primarily engineering is the art of the proper fixation of permanent wealth.

This association of the term of wealth creation with the function of engineering so emphasizes the relationship of value, cost, and proper use, that we readily enough recognize these terms as but functions of the science of economics, and must admit economics as being inextricably a part of engineering, and inescapably a function of the engineer.

Frequently the engineer has little if any realization of this broader aspect of his work. But the function is there, and with it the need for its better understanding and use. A better appreciation of this need should stimulate a better preparation to fill it, to expand and develop and capitalize it, and in consequence to open up better opportunities for better engineers.

Can this be done, and how? These questions immediately arise, and they must be met by the one answer—in group action, in broad studies of fields, and in subsequent individual preparation to take full advantage of the larger, wider scope of activity, the means and tools that we can prepare ourselves to use, not only for our own good, but in the broader advancement and service of society.

Social Responsibility

Improvements in technology and management have always tended immediately to throw workers out of employment. The continuing, insistent need for the lowering of costs to meet mass distribution opportunities would indicate this factor as becoming increasingly significant and operative. Strictly from the engineer's viewpoint, it would seem that this function would necessarily involve an increasing demand and use for his services, a trend directly opposite to that of other workers in general. If this creates or shows the way to a greater opportunity for the engineer, does it not incur a corresponding obligation? Can we expect to feed ourselves from the larders of a society built around and on foundations outlined by engineering and the engineering type of mind, with no regard to the superstructure and the broader disarrangements of social economics that inevitably follow?

With a millennium of plenty and threatened starvation face to face in the greatest paradox of human history; with applied technology a major cause of the deprivation of capacity to buy; can the engineer pride himself on his purely professional objective of efficient production, while humanity and society in a bewilderment of uncompensated idleness query why, and what is the use of this millennium? Can the engineer content himself with exercising his art merely for the opportunity of use or remuneration, and not go the one further step necessary? Must he not judge the total social value of his product, and qualify its use with some limitations or auxiliary procedure in application, that will tend to insure its use as a plus value to all society, rather than as a means of localized and quick profit, with no regard to ultimate social consequences?

Problems of Using Goods

After all, the creation or production of goods would appear, offhand, to be a much more difficult task than the problem of making it possible for people to use them. Have we gone as far as we can in lowering the cost of production? Perhaps not; but why not apply the same processes of deliberate analysis to the task of lowering the cost of distribution and increasing the power of consumption at the same time?

Distribution has never had the coordination, the get-down-to-bedrock, intensive application of technical research that it needs to shorten the path and decrease the cost from the producer to the point of potential consumption. It should respond as readily as has production to studied cost lowering; and the technical mind, the engineering type of approach and direction, is the channel for solution.

Consumption, on the other hand, concerned with economics, sociology, and business practice, is a much more involved problem than either production or distribution. Yet the maintaining or raising of the capacity to buy is the only final problem of consumption; for the desire to possess is inherent in humanity, and we can assume safely that, with a reasonably assured capacity to buy brought to given or higher levels, the rate of consumption automatically would respond in direct proportion.

More thought toward mass distribution and mass consumption should give as great rewards to the engineer as it certainly would to society as a whole. Through the use of an engineering type of thought and direction, such an emancipated society might find itself eventually not only in possession of the fruits of production, but with the time and leisure in which to enjoy them.

Engineer's Own Responsibility

Too long the engineer has been given to considering his scope of application confined by his already accepted types of professional activity. Because of our sense of interference, of stepping outside of our own designated field, we are inarticulate, and watch the big parade go by, largely as spectators. Not to see the errors of directionless, would-be, but too often futile, leadership, could be excused. But to be able to see them, to have the opportunity of becoming an adviser and a leader in enterprises and community problems, and not to accept this opportunity, is an ill-becoming shirking of responsibility that in the end is a costly commentary on our unnatural reserve and our seemingly dog-in-the-manger apathy. This apparent unconcern and its resulting sense of security make the engineer blind to the inevitable tragedy that lies ahead unless he expends all he can of thought and effort in the solution of the problem. Straight thinking, direct approach, and hew-to-the-line action alone can solve the economic and social problems of society, and provide a real, instead of a false and dangerous, sense of security.

For an answer to all our problems of individual and professional benefit, of social and economic welfare, we may look rightly only to ourselves. We have the capacity—for what the job may be worth—of making or remaking the physical aspects of worlds. If some small portion of this capacity, through organized use and direction, could be aimed toward the solution of our professional difficulties, and in turn be employed in a larger consideration of the problems of society that touch so closely upon our own normal activities, I believe we could quickly justify a renewed and a very general confidence in the capacity of the engineer, and generate a much larger faith in his leadership.

It is possible that in the small beginnings of the Engineering-Economics and Finance Division, we may have the germ of this greater possibility of personal benefit through the better equipping of the engineer to serve the larger requirements of business and commerce, and the great social, political, and economic needs of civilization.

Bridge Clearances Over Navigable Waterways

By J. F. COLEMAN
PAST-PRESIDENT AMERICAN SOCIETY OF CIVIL ENGINEERS
J. F. COLEMAN ENGINEERING COMPANY, NEW ORLEANS

WITH the coming of the automobile and the resulting increased importance and bulk of highway traffic, this question of allowable bridge clearances has received growing emphasis. Stream crossings are necessary both for rail and motor traffic, and they should not be made prohibitive in cost. Complaints of the excessively severe requirements of the U.S. Government as to clearances and spans led the Board of Direction of the Society to suggest that the Engineering-Economics and Finance Division appoint a committee to look into this complex problem. In this article, originally presented before this Division on October 9, at the St. Paul Meeting of the Society, Mr. Coleman explains the origin of the controversy and outlines some of its outstanding phases which have been suggested for the subcommittee's study.

IN a country as vast as the United States, with its numerous waterways—including those that are navigable, those that are nominally navigable, and those that may be made navigable—and its countless miles of railways, highways, power lines, and other public utilities, it is inevitable that there must be crossings of the waterways by the public utilities in many places. Where the waterways are navigable, either in fact or nominally, they are under the jurisdiction and control of the U.S. Government, and any projected crossing of them must be made to conform with Government requirements. This particular function of the governmental authority is vested in the War Department, which usually operates in these matters through the agency of the Chief Engineer of the Corps of Engineers, U.S. Army.

For many years the greater number of the structures across navigable waters were bridges constructed by or at the instance of the railways. As the railways and the users of the waterways were generally in competition with each other, controversies often arose between these two divergent interests concerning the necessary clearances, both vertical and horizontal. The bridges being the property of the railway lines, of other corporations, or of some state or subdivision of a state; and the navigable waterways being regarded as the property of the United States, it was perhaps natural to expect that the governmental authorities would protect what were considered the interests of the nation as against those of any private or local agency.

So far as I know, there has been no serious complaint to the effect that Government officials have neglected to protect the interests of navigation. On the other hand, allegations have been made from time to time that these officials, in protecting what they regarded as the interests of the United States, have sometimes exacted more than was necessary from the conflicting interests. It is alleged that movable spans have been made obligatory over streams which, although nominally navigable, were either not so in fact, or were not used; that fixed spans have been required to provide greater vertical and horizontal clearances than were necessary, thus throwing an added burden of cost, fixed charges, and operating expenses upon such traffic as used these bridges; and that in some instances the railways and the highways have been virtually denied the right or the privilege of stream crossing by the unnecessarily expensive requirements of the Government.

COMPLAINTS ARE INCREASING

Complaints of this character have been increasing in number for the past few years, and have finally resulted in a suggestion by the Board of Direction of the Society to the Engineering-Economics and Finance Division that a subcommittee be appointed to study the matter and to formulate a report, with recommendations if possible. This Division has created such a subcommittee

SIXTH STREET BRIDGE, PITTSBURGH, PA.
Fixed Span Over Navigable Water

and for the past few months it has been assembling data which its individual members have been studying. Active correspondence between the members of this committee is about to begin, with the hope that it will lead ultimately to useful conclusions. The subcommittee undertakes its assignment with no preconceived conclusions. It desires to carry forward its labors in a judicial manner, and it is anxious to obtain all possible data and suggestions from those interested in the subject.

At the outset, it should be stated that it seems fair to presume that the War Department and the Corps of Engineers are as anxious to reach fair and just conclusions with respect to these questions as any of us would be were we members of that corps, or officials of that department. If the laws or rules by which the department has been governed in the past are not sufficiently elastic, perhaps they may be amended upon proper presentation to the authorities.

THREE MAIN ELEMENTS OF THE PROBLEM

In the letters addressed by the secretary of the Engineering-Economics and Finance Division to those whose services on the subcommittee were sought, it was suggested that, for purposes of discussion, the subject of clearances could be divided into three parts, as follows:

1. Economical clearances for crossings of important waterways, which carry large volumes of traffic in large as well as small vessels of various types
2. Crossings of waterways which are classed as navigable although they are not used by commercial vessels
3. The determination of a "high-water" datum which is to be used as a basis for fixing vertical clearances

Kill Van Kull Arch, Named Bayonne Bridge
Longest Steel Arch in the World, Dedicated November 14, 1931, Connecting Staten Island, N.Y., and Bayonne, N.J., and Providing a Span of 1,675 Ft. Between Centers of Arch Bearings, and a Height of 150 Ft.

It was further suggested in those letters that one of the first things to prepare might be a statement of actual experiences and examples of avoidable wastes at crossings of waterways of various types.

Later, J. D. Galloway, M. Am. Soc. C.E., a member of the subcommittee, suggested a number of factors which bear on the problem, somewhat amplifying each of these for the purpose of indicating the possible extent of investigation and development of information. Among such factors he listed the following:

1. The nature of the bridge traffic (railway or highway) as affecting design (grades, approaches, and similar factors)
2. The nature of the waterway and its traffic (the existence of harbors for ocean-going vessels on bays or rivers); of river harbors and river traffic; or a combination of both
3. Present conditions and tendencies in ship and steamer construction and in the development of river traffic
4. Bridges over waterways and their clearances
5. The nature and effect of governmental restrictions
6. The economic aspects of the problem as affected by long spans and high vertical clearances

Wabash Avenue Bridge, Chicago
Bascule Over Chicago River, Awarded the 1930 Prize for Beauty by the American Institute of Steel Construction

The few points which have been briefly touched upon here are susceptible of almost indefinite expansion, and will present some idea as to the breadth and scope of the subject. They at least point to the certainty that no merely superficial analysis will produce results which would be satisfying either to the subcommittee or to others who are interested.

NO STANDARDS UNIVERSALLY APPLICABLE

It will be recognized on the briefest thought that no general standards as to either horizontal or vertical clearances can be evolved which will be universally applicable. Yet it may be possible to evolve methods to be applied in the consideration of these waterway crossings which will produce improved results.

If there has been a lack of balance between the consideration given to the use of waterways and that given to the use of railways, highways, and the like, it may be possible to discover some means whereby the desired balance can be obtained. If insufficient study has been given to the economics of some of these situations, perhaps the subcommittee can be of assistance in bringing about some improvement.

The subcommittee is not only willing but anxious to be helpful in dealing with this vexing problem, and earnestly wishes to pursue its studies impartially and without bias of any kind. It will welcome data and suggestions from any source and promises careful consideration of all such contributions.

Executing Chicago's Regional Plan

By Robert Kingery

General Manager, Chicago Regional Planning Association

Only a few years ago community planning was considered a waste of funds. People said that it was impossible to plan the development of a region, that it would grow at the will of uncontrolled influences. More recently, however, the experience of many villages, cities, and communities has proved that planning is possible, practical, and successful. Almost every important city now has a plan and is developing in accordance with that plan.

Seven years ago an association of the municipal governments of the metropolitan area of Chicago was formed for the purpose of guiding the development of the region of Chicago. This organization coordinates the plans that are being developed by such local governing bodies as county and park boards, sanitary districts, and other civic groups within a 50-mile radius of the city limits. The interesting and successful methods employed by this Chicago Regional Planning Association are described by Mr. Kingery in this abstract of his paper presented at the St. Paul Meeting of the Society, before the City Planning Division on October 9.

It is at the centers of metropolitan population, where a few separate municipalities have come together, that planning problems are more acute and that plans are more difficult of execution. Such problems are common to several metropolitan regions, so an outline of what has actually been done by the Chicago method of regional planning may reveal experiences which will be helpful to other metropolitan centers.

By the Chicago method of regional planning is meant the co-operative scheme of maintaining a central planning body, which is an association of many separate counties, cities or villages, park districts, and other municipal corporations, as well as of civic bodies.

For nearly seven years, the Chicago Regional Planning Association has held rigidly to two basic policies: (1) coordination of the many city, village, county, and state plans into a composite whole, and (2) independent investigation of planning principles so that plans may be laid upon sound and scientific foundations.

The growth of metropolitan centers is based upon the natural resources of the region and upon the resulting industry and commerce. Therefore, regional planners for such areas must first make provision for industrial expansion by considering the past history of the region and forecasting the future of its various industries. By determining along broad lines the future growth of basic industries, planners can forecast and make provision for future population.

With a background of as many as 13 different estimates made by public utility companies and individuals whose business it is to forecast population, such forecasts have been made in the region of Chicago for each decade up to 1960. A forecast map is shown in Fig. 1. Since forecasts of the 1930 population, made in 1925, were found to be less than one fifth of one per cent in error when the 1930 census returns came in, people have come generally to have justifiable confidence in these predictions.

With such forecasts of industry and population available, the several divisions of the community can be scheduled. Industry can be allotted appropriate areas; business can be located in others; residential zones can be laid out with due regard to industry and business; parks and playgrounds can be planned; and even golf courses and cemeteries can be provided for in accordance with the expected growth of population.

Fig. 1. Population Forecast for the Chicago Region
When and Where the 1920 Population Will Be Doubled

result of the recommendations and aid of the Chicago Regional Planning Association, and all of them are

This results in the annual acquisition of between 1,500 and 2,000 acres of public recreation space by all of

It is known that each year brings 120,000 people into the metropolitan region—60,000 to the city itself, and 60,000 to the suburban communities within 50 miles from the city limits. While the Chicago region now has more than 5,000,000 people, it will in 1960

Constructive Results of the Chicago Regional Plan
300 Miles of Connected Wide Pavement Built in 5 Years

Setback Lines Established in More Than 50 Localities
Practical Results on Main Business Street, Libertyville, Ill.

have a population of nearly 9,000,000. So plans are being made to take care of this number. For each 1,000 people, 110 acres are being provided as follows: 4 acres for industrial land; $1^1/_2$ acres for business property; 80 acres for residential property; 10 acres for park, playground, and school land; 8 acres for outer parks or forest preserves; and 6 acres for golf. In addition, there is land devoted to railroads and yards, power line rights-of-way, water courses, farms, and vacant lands.

Bed of Old Illinois and Michigan Canal to Be a Park Drive
Existing Bridges to Be Used for Grade Separations

HIGHWAY PLANNING COORDINATED

In the past, every small community in Chicago had its own system of streets, many of which did not connect directly with adjacent systems. To a considerable extent this situation has been corrected through sane, cooperative regional planning, but there is more of this work to do. After five years of planning, the metropolitan region of Chicago had almost 280 miles of 40-ft. pavement, and provision was made in the 1931 budgets of the several states, counties, and cities for the construction of 140 additional miles of wide pavement. The entire 3,000 miles in the system of state and county highway pavement in metropolitan Chicago have been connected, with the exception of a few gaps between communities that still remain to be completed.

Street widths in the municipalities inside the city area have been standardized to 10 ft. for each moving traffic lane and 8 ft. for parking parallel to the curb, and these standards are being applied as rapidly as possible to every pavement laid. The location of underground utilities and pole lines in highways was standardized after a series of meetings of officials, and now a definite space in both state and county highways is allotted to them. Recent control of subdivision platting brought to the metropolitan area several hundred miles of dedicated streets and highways, which are connected up in a system of thoroughfares 80 ft., 100 ft., and 200 ft. wide.

ZONING BOTH POPULAR AND NECESSARY

Over 90 per cent of the municipal population of regional Chicago lives in the 78 zoned communities. Each of these enlightened municipalities has granted its citizens and property owners the protection afforded by a carefully planned and well administered zoning ordinance. More than half of these zoning plans in the cooperating communities have been drafted as a

result of the recommendations and aid of the Chicago Regional Planning Association, and all of them are kept informed of the best zoning practice and court decisions by the association's service.

Zoning ordinances usually classify property into four main divisions—industrial, commercial, apartment, and residential—and for each of these divisions, which is definitely marked out, there are regulations concerning the construction of buildings and the use of the land. The cooperative feature of this zoning is that each community must give consideration to nearby property in allotting certain uses to a territory. Usually too much business property is demanded by local people. As a guide in zoning, the regional planners of the Chicago area made studies and found out just how much of such property is needed by a community. This proved to be almost exactly 50 ft. of frontage for each 100 persons. Thus a scientific basis has been established for the classification of property for business uses.

WITHIN FIFTY MILES OF CHICAGO
Of the 58,000 Acres of Public Recreation Land in the Region of Chicago, Over 35,000 Acres Are in Forest Preserves

City or Village	Parks and Playgrounds: Acres of Parks	Acres of Playgrounds	Acres of Schoolgrounds	Total Acres	Population 1930 Census	Acres of Park Per 1000 Persons
Arlington Heights			23.5	23.5	4,997	4.7
Aurora	216.0	33.0		249.0	46,589	5.3
Barrington	4.4			4.4	3,213	1.4
Bensenville			19.0	19.0	1,680	11.3
Berwyn	20.0		3.1	23.1	47,027	0.5
Blue Island	20.0		5.0	25.0	16,534	1.5
Calumet City	10.0		17.9	27.9	12,298	2.3
Calumet Park			2.0	2.0	1429	1.4
Chicago Heights	15.0		32.0	47.0	22,321	2.1
Chicago Ridge			1.0	1.0	269	3.7
Cicero	37.6		11.0	48.6	66,602	0.7
Clarendon Hills	1.0		19.0	20.0	933	21.4
Crete	20.0		10.0	30.0	1,429	21.0
Crystal Lake	26.0		19.0	45.0	3,732	12.1
Deerfield			[illegible]	[illegible]	[illegible]	[illegible]

A GUIDE TO COMMUNITIES IN ACQUIRING ADEQUATE PARK ACREAGE
Section of Leaflet Prepared by the Regional Planning Association

By constant effort the municipal park officials and the public are kept informed of park, playground, and "outer belt forest" needs, and specific proposals for the addition of such park lands are made and carried out by cooperation with the respective official bodies.

This results in the annual acquisition of between 1,500 and 2,000 acres of public recreation space by all of these authorities. In the region of Chicago there are now approximately 58,000 acres of state and county park lands, and there are more than 33,000 acres of privately owned lands devoted to golf. Cook County alone has almost one third of the 105,000 acres of county-owned park reserves in the United States.

With 31 improved airports, and the three additional intermediate landing fields of the U.S. Department of Commerce, the region of Chicago is already well equipped for air transportation. Surveys of more than 200 additional potential airport sites have been made, and the maps are now available to those who may have occasion to develop such facilities.

Planning work in the Chicago region has been so simplified that the expense of carrying it on is small. The immediate benefits, however, are great, and the future cash value of such far-seeing efforts is incalculable. Only a small central staff is maintained, and this is on a budget of under $60,000 per year. No effort is made to duplicate the engineering departments of city, county, or state for the purpose of drawing detailed plans. The regional plan is not, and may never be, completed, but there are general plans providing for all phases of activity which are being constantly improved and modified to conform with changing and unforseen conditions.

The organization of the association is simple. A president, five vice-presidents, a secretary, and a treasurer are elected annually, and in addition there are 30 directors, each representing some section of the region. The terms of 10 directors expire annually so that at least 20 of the 38 officials continue in charge of the associations' activities, thereby assuring continuity of policy. For more than seven years D. H. Burnham has served as president.

R = Residence Districts, A = Apartment Districts, C = Commercial Districts, I = Industrial Districts

Population	Cities and Villages	Maximum Density: Families per Acre R	A	C	I	Percentage of Lot Covered: Corner Lots R	A	C	I	Interior Lots R	A	C	I	DIS[...] Set Back: Front yard in Feet or % of lot depth R	A
Population under 5,000	Bannockburn	1-2		30		20-30				20-30				30-40	
	Chicago Ridge	5	13-20	20	20									25	15
	Clarendon Hills	8		8	8	35		90	90	30		90	90	40	
	Deerfield	6	14	14	14	35	50	90	90	30	40	90	90	30	30
	Flossmoor	4				35	65	65		25	75	75		30	
	Franklin Park													20	
	Glenview	8				35	40	90	90	25	30	90	90	30	30
	Golf	4-8		8		30-50				30-40				40-20	
	Hazelcrest	7	14-24	48	48	40	30-90	90	90	35	40-50	90	90	20	15
	Highland Ind.	11	11											25	25
	Lake Bluff	4-6	14	14	14	35	50	90	90	30	40	90	90	35-25	15
	Mount Prospect	6	12	12	12	55	90	90	90	50	90	90	90	30	
	Mundelein	8	16	30	14	35	50	90	90	30	40	90	90	30	20
	Northbrook	7	16			55	35	90	90	50	50	90	90	[illegible]	[illegible]
	Northfield	6	10	10	9	35	40	90	90	30	30	90	90	30	20
	North Riverside	11	11			55	55	90	90	50	50	90	90	20	
	Oak Lawn	[illegible]	25	62	25	40	60	90	90	35	50	90	90	20	15
	Orland Park	4	8	8	8	35	40	85	40	30	30	25	30	30	25
	Palatine							80				80		50	50
	Palos Park	2	4	4	4	35	40	90	90	25	30	90	90	50	50
	Roselle	6	12-24	12	12	35	50-60	90	90	30	40-60	90	90	20	20
	Tessville		36	36	36										25
	Tinley Park	6				75	75	90	90	60	60	90	90	20	20

SECTION OF A CHARTED SUMMARY OF ZONING ORDINANCES
Prepared and Distributed by the Chicago Regional Planning Association

Grand Rapids Improves Its Sanitation

Storm Relief and Sewage Treatment Provided

COMPLETION of the municipal sewage treatment plant at Grand Rapids, in October 1930, finally met the demands of the Supreme Court injunction of December 1913 requiring that the city discontinue discharge of raw sewage into the Grand River. In the years following this court decree, while various delays were permitted the city, there was a rapid expansion of the municipal sewerage network. This has now been connected in a comprehensive system for storm relief, protection from river floods, and sewage treatment. The treatment plant, designed to serve a population of 250,000, is equipped for separate sedimentation and sludge digestion, with provision for final treatment by aeration at some future time. Gas from the digesting sludge is collected and utilized.

These two articles on the Grand Rapids storm relief and sewage treatment projects have been abstracted from papers presented before the Sanitary Division on October 8, at the St. Paul Meeting of the Society. Events leading up to the $5,000,000 bond issue of 1923 for the construction of relief sewers and a sewage treatment works are related by Mr. Adams, while Mr. Velzy describes the design and construction of the treatment plant itself.

River Pollution Relieved and Sewer System Expanded

By Milton P. Adams

Executive Secretary and Engineer, Michigan Stream Control Commission, Lansing

PROBLEMS of flood control are closely related to those of sewage collection and disposal at Grand Rapids. The city is located on the Grand River about 40 river miles above its mouth at Lake Michigan. The drainage area above the city is 4,900 sq. miles. In the 160 odd miles by stream line from Jackson to Grand Rapids the river falls 325 ft., but from Grand Rapids to Lake Michigan it falls only about 6 ft. in normal stages. Grand Rapids is thus located at the point of maximum variation of river stage in times of flood. This accounts for the completion of the flood wall, trunk sewers, and flood pumping stations, from 1909 to 1913, prior to the building of the treatment plant. These combination sewerage and flood protection works cost upwards of $1,000,000.

East Side Trunk Sewer Construction in Mason Street
Rock Blasting Under Way Below Plank Mat in Foreground

The city is divided by the river into two parts, known as the East and West Side. The West Side, bordered on the east and south by the river, comprises approximately 30 per cent of the city's developed area. It is for the most part flat, approximately 25 ft. above the river bed, and was sewered on the combined plan, but with generally inadequate provision for passing storm flows. All the West Side sewers have a common outlet through either the Front Avenue or the West Side ditch trunk sewer, which are pump controlled. The flood control stations, adequate to handle the dry weather flow of sewage and some storm flows against river flood stages, were repeatedly found to be inadequate during periods of heavy run-off. Underground formations consist of gravel, muck, clay, sand, boulders, quicksand, and rock, and require, from the standpoint of necessary size and cost of construction, a considerably higher sewer cost per foot than on the East Side of the river.

Table I. Population Trend in Grand Rapids

Year	Population	Population Forecast: Year	Population Forecast: Report of Pearse, Greeley and Hansen
1880	34,000	1940	250,000
1890	60,000	1950	310,000
1900	87,565	1960	370,000
1910	112,571	1970	430,000
1920	137,634	1980	500,000
1930	168,592	....	....

Since it rises more or less rapidly from the river, the East Side is naturally divided into several distinct water-

sheds, the main drainage lines of which had been partly developed before 1923. For the most part, the East Side is sewered on the combined plan, but three large drainage districts, the Coldbrook Valley, the Silver Creek Valley, and the Plaster Creek Valley, are on the separate plan. All sanitary and combined flows from the East Side were collected before discharge to the river into either the East Side or the Monroe Avenue trunk sewer. Each of these main outlets was also pump controlled, the stations functioning during the time of annual river flood stages.

In 1930 Grand Rapids had an area of 23 sq. miles. The highest points in the city are 160 ft. above the river. East Grand Rapids, a select residential community, adjoins the city on the east. It is separately incorporated and had a population of 4,000 in 1930. Suburbs adjoining the city on its other boundaries give a total 1930 metropolitan population for the Grand Rapids district of approximately 200,000. In Table I is given the trend of population in Grand Rapids, actual and estimated.

A superior court action brought against the city by the Township of Wyoming in behalf of the Village of Grandville and other riparian interests was decided in favor of the city in 1911. On appeal to the Supreme Court in 1912, in which the Attorney-General joined with the complainants, the lower court decision was reversed. The final decree of May 1913, noted in Michigan Reports, Vol. 175, page 503, forms one of the well known decisions upholding the rights of lower riparian owners against municipal sewage pollution.

The decision, which gave the city a year in which to comply with the terms of the injunction, had the decidedly sobering effect of impressing city officials with the magnitude of the problem facing them, and resulted in changing the city's means of night soil disposal, formerly accomplished by flushing through a special hopper to the river.

Consideration of septic tanks in 1914, mentioned in the original court decision as a means of meeting the local problem, convinced officials that further time for investigation was necessary. The decree had little other effect until the time was up and an extension was requested.

About this time, Messrs. Hoad and Decker of Ann Arbor were employed by the city as consulting engineers. They recommended two Imhoff tank plants, one to be located on either side of the river. Results of test pits later sunk to the anticipated depth of these tanks, and difficulty in securing the necessary rights-of-way and plant sites, caused this plan to be altered.

FIG. 1. THE GRAND RAPIDS SEWERAGE SYSTEM

An experimental testing station consisting of woodstave tanks erected over, and sealed to, concrete sumps was designed by the consulting engineers in 1917, when certain underground construction was started by the city. With the stopping of most civil activities during the World War period, the station remained uncompleted till early in 1919, when I entered the employ of the city under the direction of G. J. Wagner, City Engineer.

Completion of the station was undertaken on April 1,

1919, and the plant was finished and put in operation on June 30 of that year. During 1919–1920 the station was operated on an experimental basis, to determine sedimentation efficiency and to carry on experiments in sludge digestion. A gaging and sampling survey of all the sewage of the city was also carried out. This was made possible by the fact that at that time all sewage was conveyed to the river through one of four main outfalls and two branches.

Underpinning the Nichols Building; the East Side Trunk Sewer Half-Mile Section Under Buildings and Other Overhead Structures

INDUSTRIAL WASTES GIVE TROUBLE

With one or two exceptions the industries of Grand Rapids, which are largely devoted to the manufacture of furniture and allied products, have produced no outstanding treatment problems. The principal difficulty disclosed by the work of the experimental station centered around the wastes of the American Box Board Company, which is engaged in the manufacture of paper and paper products from old paper and rag stock, and from straw pulp produced by the digestion of straw in the presence of lime and steam. The total wastes of this company, amounting to upwards of 5,000,000 gal. per day, contributed the major industrial wastes problem in Grand Rapids. These wastes accounted roughly for one fifth of the indicated flow of sewage to be treated, and the sludge obtained from the suspended solids would have accounted for upwards of one fourth of the municipal plant capacity. The company's water supply is taken from the river.

Conferences with company officials beginning on October 11, 1922 resulted in a decision on the part of the company to separate its industrial wastes from the city sewer and provide its own treatment with vacuum filters of the Oliver type. Separation was finally effected during the summer of 1930, and the installation of the filter or other means of treatment is promised

Two other problems were found, one caused by a local gas company, and one by the highly variable flow of tailrace (river) water from a local power development. Two small tanneries contributing to the West Side sewers in 1920 have since ceased operations, so that no tannery wastes now reach the municipal treatment plant.

Lack of objectionable odor in fresh and partially digested sludge at the experimental station was attributed to tarry wastes from the plant of the Grand Rapids Gas Light Company, which have since been eliminated by the use of oil and tar separators, by recirculation, and by the use of certain waste waters in accordance with the recommendations of the Michigan Gas Association. The principle objection to the gas house wastes in 1920 was due to the periodic "gassing" of the sewers to which the company was connected. This was caused by the liberation of illuminating gas from drip liquor which was occasionally discharged into the city's sewers after a period of detention, separation, and storage in a tank on the company's premises.

In 1922 the company instituted pretreatment and utilization of certain of its wastes, the remainder being discharged into the city sewer for joint handling with the municipal sewage.

Even before the city was granted its charter, certain power and tailrace rights were acquired from the state by the Butterworth and Lowe Company. Because of the rapids in the river at this point, these rights were of considerable value and were utilized continuously after about 1840. Against the will of the owner, the city had forced the acceptance of a connection to its new East Side trunk sewer in 1911, resulting in the abandonment of a portion of the tailrace, with its former independent river outlet. Company officials had been left with the distinct feeling that they were continuously suffering a loss in power as a result of the connection they had been compelled to accept.

A careful examination of the tailrace, together with instrumental surveys and systematic stage records made at control points above and below the company's water wheel and in the city's sewer, offered convincing proof for the first time that for all ordinary river stages the company's interests had not been injured as the result of the sewer outlet adopted ten years before. The result of this work reduced an anticipated bill of damages of $50,000, held to be correct by the owner, to the mere cost of constructing an independent outlet to the river, approximately $10,000.

PRELIMINARY REPORT ON SEWERAGE

During and previous to the period in which the experimental sewage treatment program and industrial wastes surveys were underway, the growing inadequacy of the Grand Rapids sewer system became more and more marked. Frequent flooding of basements even during storms of low intensity, as well as a casual examination of the sewer records, indicated the need for the development of a comprehensive sewerage plan.

In view of the imminence of sewage disposal and the fact that many sewers required for storm-water protection would also serve as aids to economy in future sewage plant operation, the firm of Hoad, Decker, and Drury, of Ann Arbor, were employed early in 1922 to prepare a report on a comprehensive sewerage plan. This report, submitted to the City Commission in May 1922 and later adopted as official by the commission, formed the basis for the design of the sewer relief program which was carried out.

The average rainfall at Grand Rapids for a period of 36 years is $33^3/_4$ in. per annum. After a study of existing rainfall records, a basis for the computation of run-off for the city was adopted, known as the rational method. The rainfall intensity curve is expressed as follows:

$$I = \frac{132}{20 + t}$$

This curve was held to be adequate for short storms of high intensity recurring, on the average, once in five years, and for all recorded storms of 60 minutes duration and over, occurring once in ten years. In this formula,

I = intensity of rainfall rate in inches per hour,
t = time in minutes required for concentration of run-off at the point at which computation is made.

In Table II are given the unit quantities determined upon for use in estimating the sanitary sewage flow.

TABLE II. UNIT QUANTITIES FOR USE IN ESTIMATING SANITARY SEWAGE FLOW

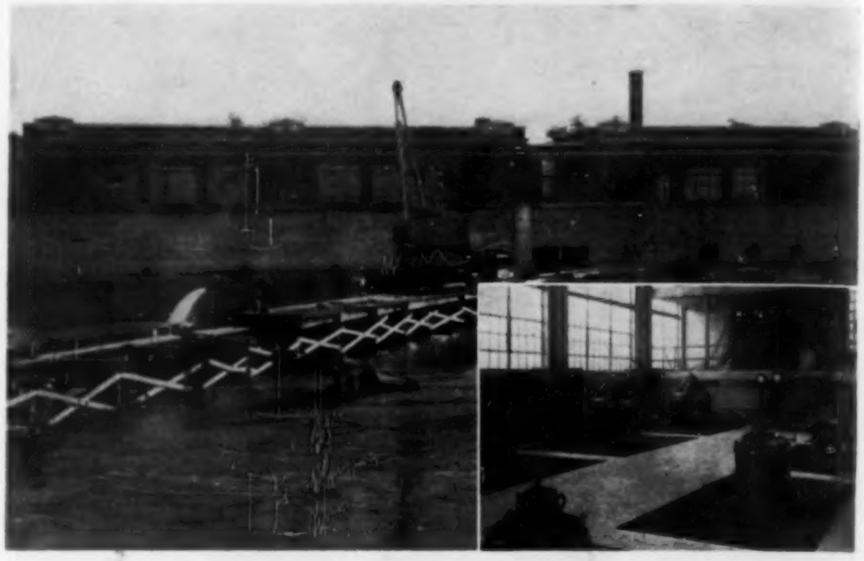
Component of Sewage	Average Flow Rate Gal. per Capita per Day	Maximum Flow Rate Gal. per Acre per Day
Domestic	50	Average $1 + \frac{18}{4\sqrt{P}}$ (P = tributary population in thousands)
Commercial:		
For closely built up downtown districts	10,000 to 20,000	18,000 to 35,000
For outlying districts	4,000 to 10,000	7,000 to 18,000
Industrial	4,000 to 6,000	8,000 to 12,000
Groundwater	..	1,000 to 1,500

As the basis for computing storm-water run-off, the following percentages of imperviousness for the different classes of development were used:

For park, cemetery, and railroad areas . . . . 0 to 5
For residential areas:
- Consisting of large estates with broad lawns, gardens, and extensive grounds 10
- Consisting of large lots and blocks, with streets partly paved 15
- Consisting of medium-sized lots and blocks, with streets fully paved 20–25
- Consisting of small lots and blocks, with streets fully paved 30–35
- Consisting of large houses closely set, with fully paved streets and alleys 40

For commercial areas:
- Containing large stores and office buildings, with fully paved streets, alleys, and courtyards 90
- Ranging in importance from areas occupied by large stores and office buildings down to districts containing small stores and markets, a varying percentage down to . . . 50

For industrial areas:
- Occupied by large factories, with fully paved streets, alleys, and some paved courts 65–80
- Occupied by small factories and shops 50–65



MARKET AVENUE PUMPING STATION
Capable of Pumping 60 M.g.d. of Sewage to the Treatment Plant or a Storm Flow of 200 M.g.d. for Flood Protection

The run-off coefficient used in the design of storm and relief sewers for impervious areas was: $c = \frac{t}{8 + t}$

and that used for pervious areas was: $c = \frac{0.25\,t}{20 + t}$

A sewage disposal plant for Grand Rapids had been required by Supreme Court injunction in 1913, and by the order of the Board of Health in 1922; and an improved sewerage system was called for by popular demand. Because of local necessity, the completion of the major part of the relief sewer program in advance of the sewage treatment plant was permitted by the State Department of Health. Parts of this program served the ends of both improved sewerage and economic sewage treatment.

Thus the problem faced in 1923 was twofold, involving first the design and construction of relief sewers for use in conjunction with the existing sewerage system, to provide adequate sewerage facilities; and second, design and construction of a sewage treatment plant, intercepting sewers, and a pumping station necessary to deliver the sewage to the plant for treatment.

TWOFOLD PROBLEM TO BE SOLVED

As previously stated, a November 1922 order of the State Department of Health calling for the construction of the disposal plant brought the necessity for action on financing to a head. This resulted in the preparation of a five- to ten-year program, which was presented to the State Board of Health for its approval early in 1923. The carrying through of this program was made contingent on state aid legislation in financing this comprehensive project without a vote of the people. The neces-

sary legislation not being forthcoming, the sanitary engineering division was given a free hand in the preparation and presentation of the necessary publicity for the conduct of a campaign of public education. Cooperation was given by many civic agencies and the campaign was carried on with the aid of the following:

Daily, weekly, community and religious newspapers; billboard advertising; street car advertising; public and branch library posters; posters in stores and homes; the city manager's open letter to each voter; luncheon club addresses; pulpit appeals; Parent-Teacher Association meetings; factory gatherings; improvement associations; public and parochial schools; women's clubs; the League of Women Voters; the Furniture Manufacturers Association; and the Citizens League.

The bond issue submitted to popular vote and approved on November 6, 1923 was for the sum of \$5,000,000. An additional \$679,740 was to be assessed directly against the property benefited as a local storm-water tax; and it was anticipated that a future bond issue of \$500,000 would be required to complete the project. Thus the total cost of the project as estimated in 1923 was \$6,179,740.

A re-study of the preliminary profiles and estimates resulted in contract plans and specifications being prepared for the first projects. Due to the imminence of necessary paving and other improvements, the original four-year plan was changed to some extent; and for the purpose of making more attractive contracts, projects scheduled for different years were grouped together in certain cases to accomplish this end.

Study of the program before the city disclosed a large footage of relief-sewer and storm-drain construction ranging in size from 6 ft. 6 in. up to 11 ft. 6 in. in diameter. Believing that this work would best lend itself to a monolithic type of construction, it was found that the use of steel arch forms of the required size would have general use throughout the program on projects in different parts of the city. Consequently, a contract with the Blaw-Knox Company was entered into on a program leasing basis, as a result of which three sets of steel forms for use in constructing arches for sewers of the semi-elliptical type were made.

Each set of forms contained 100 lin. ft. of form divided in 5-ft. half sections. Each set was accompanied by two travelers capable of moving from 20 to 25 ft. of form as a unit, although to accomplish certain size ranges the telescoping feature could not be utilized on all projects. The local type designation and size range for sewers constructed over each set of forms are as follows:

Type J	6 ft. 6 in. to 8 ft. 0 in.
Type R	9 ft. 6 in. to 10 ft. 6 in.
Type K	10 ft. 6 in. to 11 ft. 6 in.

By arranging for these forms in advance and offering them without cost for the use of bidders, uniformly good work was secured with both experienced and inexperienced contractors with whom the division had to work. The results were satisfactory in effecting generally lower bid prices for the work and gave the city a linear foot form cost ranging from 20 to 45 cents.

Most of the Grand Rapids work was in open cut, in which all types of underground conditions and construction problems were encountered. Underground conditions are not suited at Grand Rapids for tunnel work, although approximately 5,000 ft. of this type of work was completed in three different projects during the program, for the purpose of reducing traffic hazards and saving the existing pavements.

Bids were generally taken on an open-cut price basis, and the price paid contractors for tunnel work was a lump sum price per foot, based on the open-cut bid price plus the city's saving in replacement costs estimated in advance, for paving, track supports, and underground replacement work made unnecessary with the tunnel construction. On March 31, 1928, with approximately \$3,350,000 expended, the total engineering and inspection cost at Grand Rapids, including consulting engineers' fees where these services were required, amounted to 3.7 per cent of the value of the completed work.

In carrying out the relief program, a little over two thirds of the city's area was sewered on the combined plan, the remainder being on the separate plan. It was necessary to follow very largely the original plan of sewering the city. In those districts originally sewered on the separate plan, the relief work has largely involved the construction of adequate storm drains, with relief overflows from the sanitary trunk sewers provided at appropriate points.

On the West Side of the river, where the combined plan of sewage collection exists, and on part of the East Side, the relief sewer work has taken the form of providing relief trunk sewers working in parallel with, and in conjunction with, the inadequate combined system which existed in 1923. This being the case, the storm water accumulated in the separate system is spilled at various control points into the storm-water drains; and the storm water accumulated in the combined sewers is released from behind backwater gates at the West Side ditch, Wealthy Street, and Market Avenue pumping stations. Final control in this matter, and protection of the treatment plant is accomplished at the Market Avenue pumping station by the manipulation of the sewage well level there.

SANITARY SURVEY OF THE GRAND RIVER

As the time for the design of the treatment plant approached, the division found itself with two state orders indicating the necessary degree of treatment: the Supreme Court decision of 1913, indicating that septic tanks were sufficient for treating the city's sewage; and the State Department order of 1922 requiring that "all deleterious material be removed by filtration." During the period from 1913 to 1927, the population of the city increased from 120,000 to 150,000, with a greater proportional increase of connected population. A further purpose of the sanitary survey of the Grand River was to accurately determine the extent and effect of the city's pollution on the river during the summer months, which would also serve later as a basis for measuring the degree of improvement expected with the construction and operation of a treatment plant.

Results of this survey left the division with the conclusion that partial treatment of the sewage of Grand Rapids would not suffice to correct the local problem during all periods of the year. This view was later concurred in by the city's consulting engineers, Pearse, Greeley, and Hansen of Chicago, in their report on sewage disposal. In March 1928, Charles R. Velzy of this firm came to Grand Rapids as resident engineer for his firm,

taking charge of the plant design and preparation of contract plans and specifications, heading the city's sanitary engineering organization, which had been developed while the sewer construction project was in process of construction. The plant was constructed for the city under the immediate supervision of James R. Rumsey, M. Am. Soc. C.E., as construction engineer, with the firm of Pearse, Greeley, and Hansen, as consultants.

In November 1923 the favorable popular vote on the $5,000,000 bond issue, permitted the commencement of construction. By October 1931 upwards of $4,600,000 of this sum had been expended and the treatment plant was in operation. The remainder of the bond issue is now being expended to complete the relief sewer program

Primary Sewage Treatment Works Completed

By C. R. VELZY

ASSISTANT ENGINEER, PEARSE, GREELEY, AND HANSEN, CHICAGO

DESIGNED in 1928, the sewage treatment works of Grand Rapids were built in 1929 and 1930 and placed in operation in November 1930. The sources of data for the design were studies by the Sanitary Engineering Division of Grand Rapids, the studies and report of Pearse, Greeley, and Hansen, submitted in March 1928, and Government publications of the records on Grand River. The studies by the city's sanitary engineering division included sewer gagings at a number of the outlets, analyses of the sewages from the various sewer districts, and a sanitary survey of the Grand River from Jackson, Mich., to Lake Michigan, with particular reference to the conditions below Grand Rapids. The report of Pearse, Greeley, and Hansen summarized the data available and drew conclusions in particular on the following three questions:

1. Degree of treatment which should be provided
2. Type of treatment works which should be adopted
3. Suitability of the site which had already been secured by the city

With an estimated population of 157,000 connected to the sewers at the time of design, the present works were laid out for a population of 250,000, with provisions for increasing the ultimate capacity to twice that number. From the sewer gagings made by the city's sanitary engineering division, it was estimated that the dry weather flow at the time of design was 25.0 m.g.d. This is equivalent to a daily flow of 159 gal. per capita. It was estimated that when the population reached 250,000, the per capita flow would be at the rate of 130 gal., equivalent to 32.5 m.g.d., and that when the population reached 500,000, the per capita flow would be 106 gal., equivalent to 53.0 m.g.d.

The many analyses of sewage from the various districts during the eight to ten years previous to the design of the treatment works indicated the characteristics to be expected. It was estimated that with a population of 250,000 and a flow of 32.5 m.g.d., the sewage would contain 185 parts per million (p.p.m.) of suspended matter and would have a 20-day bio-chemical oxygen demand (B.O.D.) of 225 p.p.m. This sewage would not include the wastes from the box board factory from which comes the largest amount of industrial sewage, but would include all the relatively dry and minor industries of the city. The sewage from the box board factory is not to be received in the city sewers.

A study of the sanitary condition of the river indicated a rather close balance between the available dissolved oxygen in the river and the loading imposed by the sewage from the city and from the industries of Grand Rapids after treatment by sedimentation. There was also the probability that after sedimentation only there would be some sludge deposits in the river, due to the very low velocities below the city.

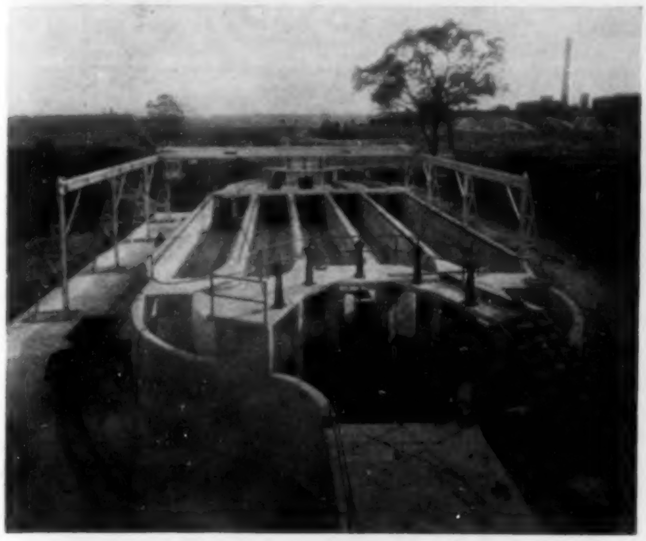
The report compared four general projects: clarification by Imhoff tanks or separate sludge digestion, and sedimentation with secondary treatment by sprinkling filters or by aeration. The conclusions reached were that: (1) some treatment beyond sedimentation alone should be provided; (2) that sedimentation with separate digestion tanks and aeration was the type of plant most suitable; and (3) that the site already secured by the city was suitable for this type of treatment works. The total annual cost for aeration with sedimentation was only slightly higher than for sprinkling filters and it involved a lower first cost, which in this case was a pertinent point because the funds available were only sufficient to meet this first cost.

The site for the treatment works was located on the river at the southern end of town. It was cut near its eastern end by Plaster Creek. As designed, the treatment works consisted of coarse screens, a grit chamber, primary settling tanks, aeration tanks, final settling tanks, sludge digestion tanks, and a pumping station, sludge storage tanks, sludge beds, and a main building housing blowers, workshop, garage, laboratory, and office rooms. There were also included about 4,000 ft. of inlet sewer from the Market Avenue pumping station to the plant site; a dike surrounding the structures (covering 56 acres of ground), for flood protection; a relocation of about 2,000 ft. of Plaster Creek to divert its course outside the dike; a bridge over the creek in its new location, to serve as the entrance road to the plant; and, at some future time, a proposed boulevard along the river bank and an outfall to the river.

Ample provision for expansion was made in all structures. The screens and grit chamber were designed for the ultimate 1980 flows, but other structures were designed for the flows expected in 1940 with space allowed adjacent to them for expansion to double, or in some cases more than double, their size. In sludge digestion structures and sludge drying beds space was left for tripling the present structures.

In the arrangement of the structures an attempt was

made to keep the line of flow as straight and short as possible and in a downstream direction with reference to the river. Gates for the control of flow were centralized at two points. This involved the design of somewhat complicated control chambers, but resulted in short conduits, simplicity of operation, and good appearance. The line of flow for the sludge begins at the primary settling tanks and follows a more or less direct route through the digestion and storage tanks to



Grand Rapids Grit Chamber During Construction
Trusses on Sludge Digestion Tanks in Right Background

the drying beds, which are located on that part of the site most accessible to the road.

In the design of the coarse screen, consideration was given to mechanical rakes. The design adopted, however, is that of a hand-raked bar screen built in a chamber of sufficient size to permit the later installation of mechanical rakes, should that be desired. The screen is enclosed in a separate building, which may be heated to facilitate operation during the winter. Some of the floor slabs are removable to simplify the installation of mechanical rakes. At the head of the screen a drainage platform is provided, from which screenings can readily be dumped into cars on a depressed track running alongside the screens.

The grit chamber adopted, after consideration of several types, including mechanical detritors, consists of a series of five plain grit passes, two of which are 10 ft. wide and three 8 ft. wide. They are 60 ft. long and provide a maximum water depth of 5.5 ft., with a grit storage in the bottom 1.5 ft. deep. In the design of the entrance conduit to these channels an attempt was made to obtain a uniform velocity at the head of the channel, free from eddies and cross currents. This was done by laying out curves followed by a short length of straight conduit, which terminates with sides diverging to the width of the grit pass.

One of the most interesting problems encountered in the plant design was in connection with the hydraulics of the grit chamber. It was designed to lose a minimum of head in order that the plant outlet could be kept at a maximum elevation. The ordinary design of a proportional weir to maintain a constant velocity in the grit chamber calls for free fall conditions and consequently an appreciable loss of head.

The design developed for this purpose consisted of an opening in a steel plate shaped like an inverted letter T. The horizontal portion of this opening is submerged at all flows and the stem, or vertical portion, is partially submerged. The velocities resulting from this weir can be easily kept between 0.9 and 1.1 ft. per sec. by bringing additional channels into operation as the flow through the grit chamber increases.

Considerable attention was given to the problem of removing grit from the channels of the grit chamber. Openings from each channel above the grit level were provided which draw off the supernatant sewage when a channel is closed. The grit is drained through a tile laid in a longitudinal trough along the center of the channel. An illustration shows how the grit is then removed by means of a traveling crane spanning the five channels. From his cab, the operator can remove the grit from any chamber with a single line clamshell bucket and load it into industrial cars alongside the structure.

Primary sedimentation was set up on the basis of a detention period of 1.5 hours for the average flow for a population of 250,000, which was estimated at 32.5 m.g.d. This calls for a total volume of 272,000 cu. ft.

A number of alternates for primary tanks were thought to have sufficient merit to warrant making designs and taking bids on several types. Accordingly, two general designs were made on the drawings, one designated as the revolving type, and the other as the conveyor type. Considerable thought was given to the choice between four and six units as regards cost, wind action on exposed surface area, and flexibility. Four tanks of the revolving type were adopted.

Skimming devices were called for on both types of tank for removing grease and scum from the surface of the sewage. The skimmings are discharged by gravity into a separating manhole, which is provided with traps and outlets to draw off the water to the primary tank outlet conduit and to discharge the skimmings by

Primary Settling Tanks Provided for Aeration
Digestion Tanks in Background

gravity through a 12-in. tile to a low area where they may be dried, and burned or buried as may prove feasible.

The sludge digestion tanks were designed for a capacity of 1.25 cu. ft. per capita for a population of 250,000. This required four tanks 70 ft. in diameter and 25 ft.

deep. The tanks are arranged in a square, with space at the center for the sludge pumping station. These tanks are provided with fixed concrete covers and mechanisms for stirring the sludge and drawing it to the central cone, from which point it is discharged. The heating of the digestion tanks up to 90 deg. fahr. is accomplished by hot water circulating coils consisting of a single line of $2^1/_2$-in. wrought iron pipe running four times around the outside wall of the tank, and spaced 4 ft. apart. Heat is provided by burning under boilers the gas collected from the digested sludge.

The concrete roof of the tank is carried by the same truss which supports the mechanism. The roof construction, as shown in an illustration, consists of a main concrete slab carried on the bottom flanges of I-beams, supported at their middle point by hangers from the main truss, and by the sides of the tank at their ends. A cinder fill as deep as the I-beams, covered by a thin concrete slab resting on the top flanges, insulates the top of the tank.

Sludge is pumped into the tank through a cast-iron pipe, which discharges through the roof at two points. As the sludge is pumped in, the supernatant liquor is discharged through a fixed outlet consisting of an 8-in. cast-iron pipe leading from a point 20 in. below the under side of the edge of the roof through an elbow and vertical riser to a point 20 in. above the under side of the center of the roof. Gas is drawn off from two gas domes set near the center of the tank, one on either side of the supporting truss. Sampling pipes having a diameter of $2^1/_2$ in. lead from four points 5 ft. apart in elevation beginning 2.5 ft. from the bottom of the tank. These pipes are brought to a manhole and valved so that a sample may be conveniently drawn from any one.

Located at the center of the group of four digestion tanks, the sludge digestion pumping station constitutes a centralized control station for the sludge digestion process. It houses pumps for handling both raw and digested sludge, gas boilers for heating the tanks, and sludge meters from which records are obtained of the volume of sludge transferred from one point to another.

DIGESTER TANK WALLS
Constructed with Sectional Steel Forms

The station is built in three stories. The top floor is the ground floor, being on a level with the top of the digestion tanks and the ground surface around the tanks. It consists of a balcony 6 ft. wide around all four walls of the building, and contains the switchboard for the equipment. The floor below carries the sludge pumps, meters, and a control panel for operating the primary tank sludge valves. In the sub-basement or lowest floor are the heating boilers, gas meters, and accessories.

In order to provide storage space in which the sludge which accumulates during the winter months can be kept, awaiting suitable drying weather, storage tanks are provided having a volume of 1.375 cu. ft. per capita. These tanks, two in number, are unheated and are of cheaper construction than the digestion tanks. They

ROOF CONSTRUCTION OF SLUDGE DIGESTER
Insulating Cinder Fill and Concrete Top Slab to Be Placed

were built by paving the bottom and sides of a basin formed by an earth embankment, and covered by a flat slab roof carried on columns. The tanks are divided by a common wall and a gallery which houses piping and valves, and at one end, a small pumping station for discharging the sludge to the drying beds.

Two sludge bed areas were laid out, each consisting of 16 beds 50 ft. wide by 100 ft. long, and 6 beds 25 ft. wide and 100 ft. long. The sludge is distributed by means of a central sludge conduit, with a discharge opening to each bed controlled by plain steel-plate shear gates. The division walls are built of concrete plank set in concrete posts. Industrial tracks with cars and a gasoline locomotive are used in removing the dried sludge from the bed. The total area provided in this design is 190,000 sq. ft., equivalent to 0.76 sq. ft. per capita.

Although secondary treatment was not provided for in 1930, the design included aeration and final tanks and blower equipment to operate the aeration tanks. A detention period of 4.5 hours was called for in the aeration tanks, which were to be supplied with air at the rate of 0.8 to 1.0 cu. ft. per gal. It was assumed that the normal amount of return sludge introduced would be 20 per cent of the sewage flow. The aeration tanks will be of the spiral-flow type with porous plates, amounting to 10 per cent of the tank area, arranged in two rows near one side of the bottom of the tank. Concrete plate containers have been designed to rest directly on the tank floor and to hold the plates in position, with ample space for the passage of air beneath.

The final settling tanks will provide a detention period of 2.7 hours and a settling rate of 850 gal. per sq. ft. per day for the average flow. These tanks are to be equipped with revolving-type equipment.

General View of the Grand Rapids Sewage Treatment Plant

Construction work was divided into two contracts. The first was called the grading contract and included excavation of the new channel for Plaster Creek, construction of a protective dike, building of a bridge over the creek, and laying of the sewer from the Market Avenue pumping station to the plant site. The general purpose accomplished by the first contract was the protection of the site against high water for the construction work of the main contract, and the building of a road for convenient access. The second or main contract included the building of the structures of the treatment works, and the furnishing and erection of equipment.

Bids on the grading contract were received on October 10, 1928, and the work was finished the following summer. Bids on the general construction contract were received on June 19, 1929, and the work was finished in the fall of 1930. Sewage was first turned into the treatment works in the early part of October 1930. Two weeks later the opening ceremony was held, to which the citizens of the city were invited.

This formal opening was followed by a few months of readjustment. The greatest attention was required by the digestion tanks, while a number of minor adjustments had to be made on primary tanks, sludge meters, and sludge pumps. Careful records of operating results have been kept; Tables I and II show the general results.

Features of the plant design which may be considered somewhat new or unusual are the grit chamber design,

Table I. Primary Treatment of Sewage

		Screenings		Grit		Primary Sedimentation		B.O.D.	
Month 1931	Av. Flow in M.G.D.	Cu. Yd. per Day	Cu. Ft. per Million Gal.	Total per Mo. Cu.Yd.	Cu. Ft. per Million Gal.	Av. Suspended Solids P.P.M.	Removal %	P.P.M.	Removal %
April	22.2	0.47	0.57	199	8.05	252	48.4	199	35.9
May	20.7	0.40	0.52	118	4.96	154	46.3	172	32.6
June	26.2	0.31	0.32	235	8.08	175	51.3	149	40.8
July	23.4	0.27	0.31	146	5.43	172	58.7	132	42.1
August	24.3	0.66	0.73	113	4.05	133	69.0	140	43.6

Table II. Sludge Digestion

	Raw Sludge			Digested Sludge Withdrawn			Gas	
Month 1931	Volume Av. Gal. Per Day	Water %	Volatile Matter in Solids, %	Volume Av. Gal. Per Day	Water %	Volatile Matter in Solids, %	Volume Av. Cu. Ft. Per Day	B.T.U. Av. Per Cu. Ft.
April	60,357	91.0	59.4	9,140	84.9	48.6	110,510	687.8
May	48,819	93.8	65.2	9,181	86.7	47.9	159,977	706.8
June	51,817	95.4	68.8	7,923	88.8	46.7	150,450	709.0
July	43,281	95.1	65.7	6,534	89.6	47.8	147,952	675.9
August	58,613	92.4	58.7	12,026	85.9	46.6	167,458	676.0

the layout of the sludge pumping station, and provision for the storage of winter-collected sludge in low-cost tanks to await favorable drying weather.

City Planning Division Reports Progress on Three Manuals

Progress reports from the chairmen of the three Manuals committees of the City Planning Division were received at the Division meeting held in St. Paul on October 9, 1931. To advance the work of the Committee on the Location of Underground Utilities, Arthur W. Consoer, M. Am. Soc. C.E., Consulting Engineer of Chicago, has agreed to prepare a paper on this subject for the Division meeting in New York in January 1932. A second paper for the same meeting, on street names and numbers, has been assigned to J. P. Schwada, Assoc. M. Am. Soc. C.E., City Engineer of Milwaukee, chairman of the newly organized committee on this subject. The Executive Committee of the Division has approved cooperation with the American Institute of Architects at their 1932 convention in Washington, D.C.

Among the Manuals now in preparation is one on street thoroughfares. The chairman of the committee having the work in charge, W. W. Crosby, M. Am. Soc. C.E., urged members of the Division to give careful consideration to the definitions proposed in the committee's progress report (see page 1,125 of September Civil Engineering), and frankly express any suggestions they may have for the improvement of these definitions.

The committee charged with the preparation of a Manual on the Subdivision of Urban Land, Rolland S. Wallis, M. Am. Soc. C.E., Chairman, is gathering together additional material and has plans for a well illustrated, usable Manual. In connection with its work on a Manual dealing with the location of underground utilities, Chairman Consoer's committee has corresponded with the engineering staffs of a number of cities and utility companies. Results indicate that very little has been done with "subterranean street planning." However, the correspondents generally emphasize the urgent need for a code of proper construction practice in the location of underground service pipes, tunnels, and conduits.

Harold M. Lewis, *Secretary*
City Planning Division

Highway Practice in Minnesota

Modern Methods of Alignment, Maintenance, and Traffic Control

A GREAT step forward has been taken in Minnesota in transforming a network of circuitous country roads into safe and direct high-speed traffic routes. In the papers which follow, three phases of state highway practice in Minnesota are discussed by men well fitted to speak on them. Realignments have saved as much as 20 per cent of the distance between towns, eliminated grade crossings, and provided more advantageous river crossings. The newest ideas in alignment, planning, and construction are discussed in the article by Mr. Kipp.

As State Commissioner of Highways for 21 years, Mr. Babcock has had plenty of opportunity to observe the effects of highway parasites, which mar the beauty of the landscape and introduce hazards to the safety of motoring. He holds no brief for such menaces as unsightly billboards, roadside shacks, toll bridges, or hitch-hikers.

Traffic on the highways of the State of Minnesota is regulated by an able, courteous, and well trained group of 70 men. The methods employed in selecting and training these men are described by Mr. Brown. These three articles on highway practice in the State of Minnesota are abstracted from papers read on October 8, 1931, before the Highway Division of the Society at the St. Paul Meeting.

Questions of Location and Design

By O. L. Kipp

Construction Engineer

State Department of Highways, St. Paul

Since the ultimate service that may be expected from a highway depends upon its location, proper consideration should be given this subject in carrying out a highway improvement program. The most perfect design and the most expensive construction will be of little value if the location chosen for the highway does not provide a direct connection between the points to be served and an alignment which promotes comfort and safety.

Rapid development of motor transportation has made it difficult for the engineering profession to keep pace with the fundamental requirements of location. The speed of vehicles has been increased from year to year, and even now it is not possible to predict the ultimate developments in this direction. It is evident, however, that the growth of highway transportation justifies greatly improved standards of location and alignment.

DIRECT ALIGNMENT IMPORTANT

Operation costs must be considered, therefore the highway location must not be limited by the route and alignment of roads now serving the territory through which an improvement is contemplated. In many instances it is possible, by means of suitable location, to shorten the present traveled routes from 15 to 20 per cent, with no material increase in the cost of construction. State expenditures for right-of-way, which average $2,700 per mile of construction, can be fully justified on the basis of reduced construction costs alone. In fact, savings are being made continuously.

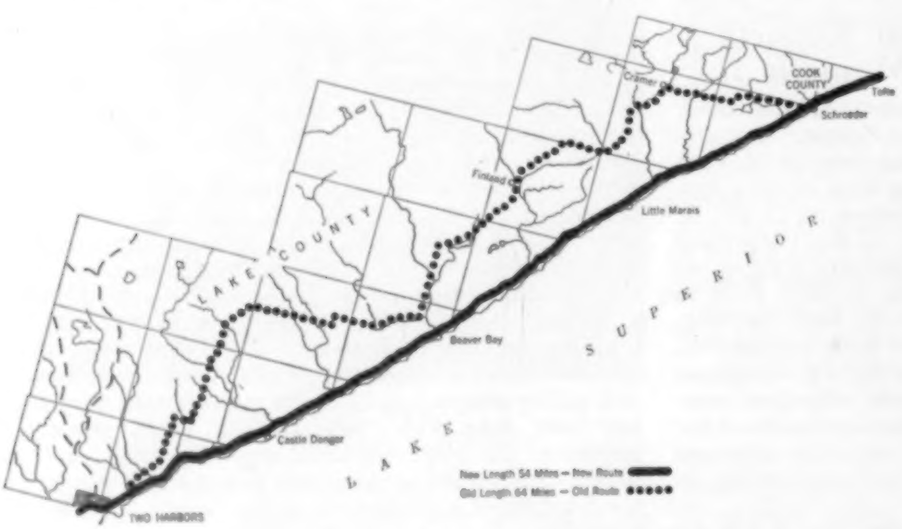


Fig. 1. Alignment Changes Save 10 Miles in a 64-Mile Route
Minnesota State Highway

It has been found possible, during the past several years of trunk highway construction in Minnesota, to reduce the length of the various routes which have been improved, an average of more than 10 per cent (Fig. 1). During 1929 and 1930, for instance, 740 miles of these trunk highways were constructed to replace 842 miles which had previously served the same sections. The sum of $1,945,000 was spent in acquiring the right-of-way for these 740 miles, but had the original alignment been followed, it would have cost approximately $3,500,000 to grade and pave the additional 102 miles. Assuming other costs per mile to be equal, a saving of $1,555,000 in construction costs was effected.

This relocation, which made possible the reduction of 102 miles in the trunk highway system, not only improved alignment but also eliminated 82 railroad grade crossings on the trunk highways, without the construction of any bridges for the separation of traffic. When the roads were originally laid out by counties, townships, and other agencies, little consideration was given to directness of route, alignment, elimination of railroad grade crossings, or other important features. Therefore, it is frequently an easy matter, with proper location, to shorten the highway, eliminate dangerous curves and sharp turns, avoid railway grade crossings, and improve the routes through cities and villages. A typical example is shown in Fig. 2.

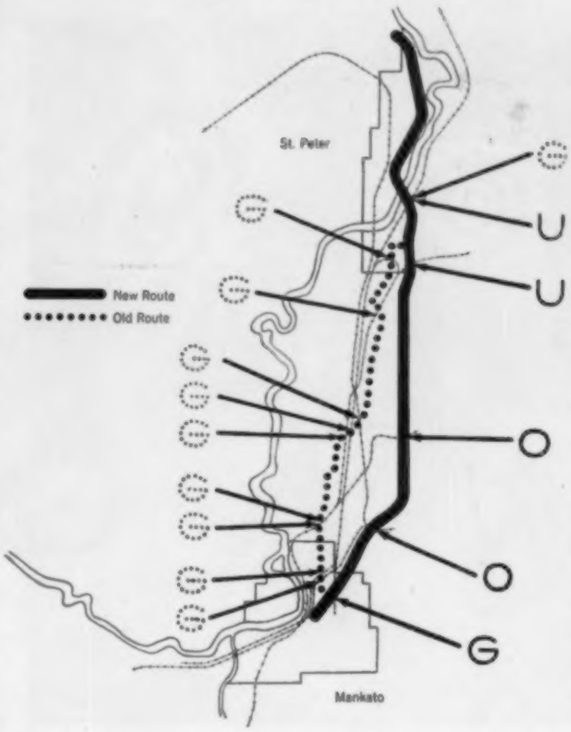


Fig. 2. Relocation Eliminates Nine Grade Crossings Between Mankato and St. Peter, Minn.

The matter of stream crossings must be given careful consideration. Formerly, almost any alignment was used in order to secure the shortest possible length of span and the cheapest type of bridge construction, as indicated in Fig. 3. While it is important to consider the cost of the bridge required, good alignment should not be sacrificed in order to effect a relatively small saving in the cost of the structure. The entire cost of the completed project, with surfacing adequate to take care of traffic through a long term of years, should be taken into consideration. If this is done a possible increase in the cost of the whole project to provide satisfactory alignment at bridge sites would ordinarily become of relatively small significance. Major changes in the alignment of the stream channel can frequently be made to advantage, as was done at the location shown in Fig. 4. This possibility should not be overlooked where it is difficult to secure good alignment adjacent to structures.

One of the most important problems in connection with trunk highway location is that of securing a satisfactory route through, or adjacent to, cities and villages. For the proper solution of this problem, the location must be such that local traffic entering a town will be adequately served by means of connecting streets, and that at the same time through traffic will be carried by or through the town with the greatest possible speed and safety.

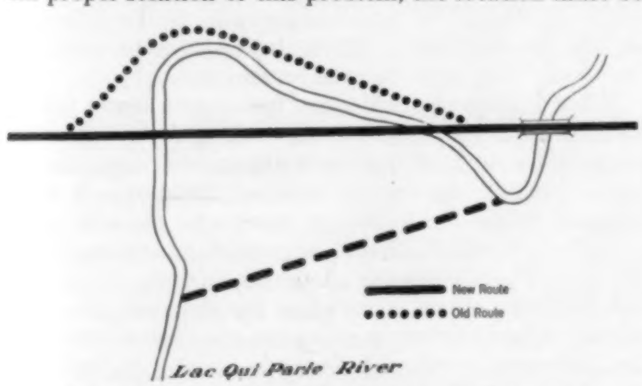


Fig. 3. Channel Change Straightens Highway Lac Qui Parle River, Minnesota

Highway design, as developed by the several state highway departments, involves many divergent ideas. The variations, however, are of a minor nature. As a result of the work of the Committee on Road Design of the American Association of State Highway Officials, the states have adopted standards of practice covering many of the essential features of road design.

Since the adoption of these recommendations, it is now standard practice in laying concrete pavements to use some suitable form of construction joint or other method of dividing the pavement longitudinally into two sections, corresponding in width to the traffic lanes. Dowel bars are installed across the joint so formed. Transverse crack control is desirable, and it is becoming customary to provide a transverse plane of weakness wherever construction joints are not provided. These planes are spaced from 20 to 50 ft. apart, depending on the nature of the foundation soil, the climate, and the aggregate. Each traffic lane is given a width of 10 ft.; two-lane highways have a 1-in. crown; and wherever there is room available a shoulder 8 ft. or more wide is built along each edge of the pavement. Concrete pavements must be at least 6 in. thick, and all unsupported edges are strengthened by thickening, by reinforcing, or by both methods. The same committee has classified roads, giving the acceptable types of construction.

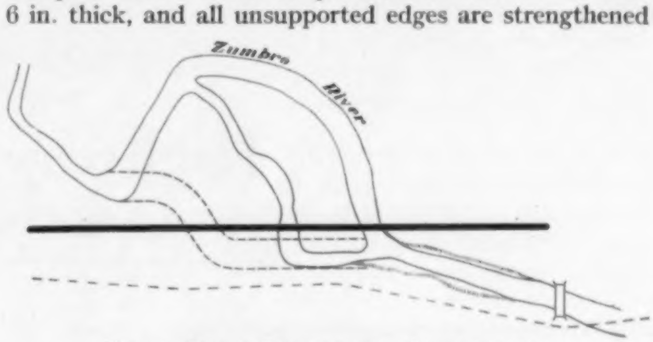


Fig. 4. River Realignment Improvement Zumbro River, Minnesota

Where changes in alignment are made up to 3 deg., they should be located at peaks in grade rather than in depressions. Sharp horizontal curves should not be combined with either convex or concave vertical curves, when relatively steep grades are involved. If a convex vertical curve is used in combination with a horizontal curve, the last mentioned should extend over the full length of the vertical curve, or even overlap it.

At railroad grade crossings, protecting signs and signals should in all cases be located at the side of the roadway and not in the center. When possible, enough additional width of right-of-way should be secured at grade crossings and all public road intersections outside of cities so that a sufficient sight distance will be provided. In connection with grade crossing eliminations, the maximum grade should be not more than 5 per cent. Other standards of alignment and sight distances should be provided. Designs should eliminate any details which might result in a traffic hazard. It is also recommended that men of proper training be employed for the esthetic development of the highways.

MOVABLE HIGHWAY BRIDGE OVER ST. CROIX RIVER
Built Jointly by the States of Minnesota and Wisconsin at Stillwater, Minn.

For super-elevation of the road surface on curves, the formula adopted in November 1930, is:

$$E = 0.067 \frac{V^2}{R}$$

where E is super-elevation in feet and V is taken at 35 miles per hour. If sharp, horizontal curvature cannot be avoided, pavement on curves sharper than 6 deg. should be widened in accordance with the formula:

$$W = 2\left(R - \sqrt{R^2 - L^2}\right) + \frac{35}{\sqrt{R}}$$

where

W = widening in feet

R = radius of the curve in feet, and

L = wheel base of the vehicle, in feet (20 ft. recommended)

While careful construction methods are undeniably important in carrying out any program of highway improvement, the fact remains that proper location, good alignment, adequate super-elevation, and other features of location and design are of paramount importance. Without attention to these features, the most expensive types of construction will not yield a return in transportation service sufficient to justify the expense of construction.

Highway Parasites

By C. M. BABCOCK
COMMISSIONER OF HIGHWAYS, STATE OF MINNESOTA, ST. PAUL

THIS subject of highway parasites is a broad one, which concerns the civil engineer not only as a road builder but also as a citizen, a taxpayer, and a road user. The highway parasite preys upon the road builder, interfering with his work, and upon the traveler, impeding his progress and threatening his safety.

These parasites are endless both in number and in variety. They made their appearance before there were any modern highways or highway systems. One of the first of them was the trail association. Doubtless many of these associations performed valuable services, both to the towns on their route and to the general cause of good roads. But many others were simply the creations of promoters and obtained funds by threats of leaving towns off the marked trails. When the funds were obtained, they gave little or nothing in return.

When highway parasites are mentioned, many people think first of billboards and advertising signs. There is no place for the ugly signs and stickers that are attached to, or painted on, fences, boulders, buildings, or trees adjacent to the right-of-way; there is no place for signs or billboards which obscure or detract in any way from the beauty of the scenery along the highway; and last, but not least, there is no place for those which create a traffic hazard either by obscuring the view of intersecting highways or railroads, or by confusing the motorist and distracting his attention from the important business of driving his car. However, I am not ready to join in

condemning signs which are kept neat and attractive and located where they do not detract from the landscape. Some of them, at least, furnish useful information to the traveler.

Billboards Barred from Minnesota Highways

Minnesota was one of the earliest states to bar all advertising signs from the highway right-of-way. A law passed in 1923 prohibits the erection of such signs and gives the highway department (in the case of state highways) and local officials (in the case of local roads) the right to remove them. But this was only one step. Many fences just outside the right-of-way are cluttered with small ugly signs, and many of the most beautiful views are spoiled by misplaced billboards. These are located on private property, but some states are making progress in the campaign against them by means of both taxation and general police power.

Signs at Junction of Two Paved Highways
Confusing to Motorists and Obstructing the View

These signs and billboards are classed as parasites because if the highway were not there they would have no value, and the land could bring no rental for sign purposes. They take advantage of the existence of the highway to interfere with the purpose for which many people travel—that is for rest and recreation, and enjoyment of the beauties of nature.

It must be recognized that outdoor advertising is an established and legitimate industry, although in some places it has gone entirely too far in offending the esthetic tastes of the public and has created actual traffic hazards. Perhaps in time advertisers will learn that through offensive advertising they are injuring themselves. Some have already learned this lesson and withdrawn their objectionable posters.

Roadside Stands Need Regulation

Prominent on the list of highway parasites are refreshment and vegetable stands, and an assortment of amusement devices. It is not fair, of course, to condemn the farmer who takes advantage of the highway to sell his own fruits and vegetables direct to the consumer, as long as he keeps far enough back from the traveled roadway to provide adequate parking space and not create a traffic hazard. But not all garden products sold along the highways are grown on the premises. Some of them are hauled out from city markets, often in poor condition, and sold at prices higher than those asked in the city stores.

The refreshment stand may also be either good or bad, depending upon how well it meets the requirements of health, safety, and beauty. Some stands are so close to the highway that they are the cause of many accidents, while others have adequate parking space and safe approaches. The same situation is true of amusement resorts.

Buildings Obstructing View on a Curve
Mendota Cut-Off, Minnesota State Highway System

Another parasite, perhaps a little more directly connected with road building than those previously mentioned, yet often beyond the control of the road builder, is the toll bridge. Generally speaking, a toll bridge has no place on any continuous state or interstate highway or on any highway carrying general public traffic. Minnesota is more fortunate in this respect than some states, for it has only one toll bridge within its borders. This is a railroad bridge which has a second deck for local highway traffic. There are several interstate toll bridges, but only one of them directly connects a trunk highway with the state highways of another state. In that case the bridge is owned by a small municipality, but because of the fact that the two states improve and mark these highways, this village is able to collect in a single year an amount larger than the cost of the bridge.

Although it would be preferable to have all bridges free, there are cases where a lack of public funds and a local rather than a general need make the toll bridge the only solution. When such structures are authorized they should if possible be owned by states or their subdivisions. If they are privately owned, it is advisable that they be in the hands of local companies with stock widely distributed among local residents, rather than in the hands of promoters who have no interest in the public welfare. In any event, every franchise for a toll bridge should contain a provision for making it free as soon as the tolls have been sufficient to retire the bonds or to pay the first cost of the structure, plus the cost of maintenance up to that time and a reasonable profit. Any toll bridge owner—whether a municipality, an individual, or a corporation—who takes advantage of helpless traffic by exacting tolls far beyond the cost of building and maintaining the structure, is a parasite. If the bridge is poorly maintained and unsafe, the offense is so much the worse.

There are parasites among motorists also, those who evade the payment of their fair share of the cost of the public roads. Many evasions of the license laws can be overcome fairly easily through efficient law enforcement. However, when motorists take advantage of the great divergence in methods of collecting road taxes by purchasing their license plates in a low-license state and using them in their own state for the rest of the year, the problem is more complex. It would be simplified if all the states would adopt more nearly uniform license rates.

BEWARE OF THE "HITCH-HIKER"

For the last place in my list of highway parasites, I have reserved one that is the most numerous, the most annoying, and the most dangerous—the "hitch-hiker." Hitch-hikers form a distinct traffic hazard. As they frequent the highways, they become increasingly bold and walk close to the main lanes of traffic. In doing this they are endangering not only themselves, but every traveler on the highway. When a driver stops to let a hitch-hiker into his car, he is taking the risk of being hit by cars going in the same direction, and when he swerves from his course to avoid hitting one of them he is running the risk of a collision with cars coming toward him.

But the most serious aspect of the matter is that hitch-hiking is transforming a large number of people, especially those who are young, into beggars. Minnesota has a paragraph in its traffic act making it a misdemeanor to stand in the traveled portion of any roadway for the purpose of soliciting a ride from the driver of any vehicle other than a public conveyance. I believe that seven other states have the same or similar provisions. The state highway patrol of Minnesota has made a determined effort to enforce this law on the state highways, and some effort in this direction has been made by local police in various cities. But the hitch-hikers are so numerous that these attempts at law enforcement are not very successful.

Motorists should be adamant to every solicitor of rides unless he is known to them or the situation is an emergency. Parents and others who have anything to do with teaching or directing children should impress upon them the danger of asking or accepting rides from strangers. With this educational work and determination on the part of car owners, the evil of hitch-hiking can be eliminated or greatly reduced.

Training a Highway Patrol

By EARLE BROWN

CHIEF PATROL OFFICER
MINNESOTA HIGHWAY PATROL, ST. PAUL

IN 1922 a bill authorizing the creation of a State Highway Patrol was passed by the Legislature of Minnesota, after several previous attempts to pass it had failed. This patrol consisted of 35 men and was under the direction of the State Highway Commissioner. In 1931 the legislature authorized the increase of this force to 70 men.

The powers of the highway patrol are not as broad as those of the state police in Pennsylvania, New York, Massachusetts, and some of the other states, but are limited to the regulation of traffic on the highways. Considering the size of Minnesota, the force is still small, but it is hoped that its number will again be doubled after its value has been further demonstrated to the legislature and the public. A campaign of courtesy among the officers of the patrol has done away with the old-time rough methods of the traffic policeman. Such methods of dealing with reputable citizens are not in vogue in Minnesota.

Whenever there are vacancies in the force, as was recently the case when it was doubled by legislative act, the waiting list, consisting of from 1,800 to 2,000 applicants, is gone over carefully. The service seems to appeal to young men, who usually do not know what hardships lie ahead of them. Selections for preliminary training are made without considerations of friendship or politics. Those selected are taken 8 or 10 miles out of the city, housed in a barn, and put through a rigorous three-months course of physical and mental training. They are kept busy from 6 a.m. to 9 p.m. and allowed to leave the training area only on Sundays. In return for all this, they receive no pay except their board and lodging. The first two weeks are filled with hard manual labor, which includes all the uninviting jobs in the neighborhood, such as cutting large quantities of cordwood. It is felt that if candidates do not leave before the two weeks are over, they are firm in their intention to become members of the state patrol.

Those who remain after this two-week period is over are given a thorough course in the traffic laws of the state. They must know what they are doing. If it is necessary to make an arrest, they must know how to handle the situation. As an advantage to themselves and to visitors, they are also given a thorough course in the geography of the state. A patrolman must be able promptly to direct visitors to any point in the state without having to consult a map or guidebook. Our business is to get the traveling public to their destinations as safely and as quickly as possible.

A complete course in first aid is required. This may enable the saving of life. Of course the men must also be expert in marksmanship and in the use and care of firearms. Every one of them can shoot with his left hand as well as with his right. It is seldom necessary to use this training, but when it is necessary, innocent bystanders are less apt to be injured if patrolmen are expert marksmen. Finally, they are given a course in self-defense—in the art of ju-jutsu, and learn 40 bone-breaking holds. If after this training the smallest man on the force cannot toss the largest over his head, he is not wanted on the patrol.

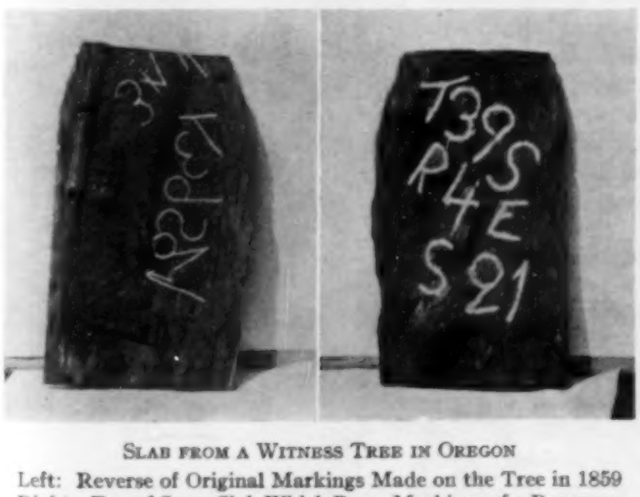
Recovering and Identifying Original Government Section Corners

By J. S. Dodds
Member American Society of Civil Engineers
Associate Professor, Civil Engineering Department, Iowa State College, Ames

Aside from practical considerations, it is an unforgettable experience to remove a slab from a blazed tree that locates a hidden section corner marked by Government surveyors a hundred years ago. A study of the official instructions under which the original survey was conducted; an understanding of the limitations due to adverse conditions of weather, topography, and inaccurate instruments; and a knowledge of the idiosyncrasies of the individual surveyor—all are necessary to a successful search for a hidden corner. This article, an abstract of the paper presented by Professor Dodds at the St. Paul Meeting of the Society before the Surveying and Mapping Division, on October 8, 1931, gives much helpful information on how to retrace the old surveys and recover the original corners.

In 1785 the Continental Congress passed the law which established the system of rectangular surveys for the public lands of the United States. That system, with only minor modifications, is in use today in all the states except the original 13, and in Kentucky, Tennessee, and Texas. With no conception of the extent of the territory available and the number of settlers to be accommodated, the law provided a simple system of surveys, descriptions, and identifications for the whole public domain. From the very beginning, the Government aimed to lay out the land by measuring distances and bearings and monumenting corners so that settlers could, with a reasonable amount of surveying, locate the various parcels for purposes of occupation. To those living in the public-land states, it may seem hardly necessary to explain the rectangular system of land surveys. There are many, however, in the other states who know only of the metes-and-bounds method of surveying land. Certain widely used textbooks make no mention of the rectangular system.

Briefly, the system subdivides the public domain into approximately rectangular tracts (allowing for the convergence of meridians) based upon townships six miles square and subdivided into 36 sections, containing about 640 acres each. The sections are usually divided into half, quarter, or quarter-quarter sections. A homestead of 160 acres was a very common claim for a settler.



Slab from a Witness Tree in Oregon
Left: Reverse of Original Markings Made on the Tree in 1859
Right: Top of Same Slab Which Bears Markings of a Resurvey Made in 1894. Markings Touched Up with Chalk for Photographic Purposes

By the system of numbering the townships in ranges and the sections in the township, it is possible to describe a certain parcel of real estate very simply. For example, a 40-acre farm in Iowa just north of Ames might be described as the southeast quarter of the southeast quarter of Section 33, Township 84 North, Range 23 West of the fifth principal meridian. The recognized abbreviation in the region of the survey, or among realtors anywhere, is S.E., S.E., 33-84N.-R.23 W., 5th P.M.

To any person familiar with the rectangular system it is not necessary to explain that this is 40 acres, or that it is near Ames, Iowa. All of that will be apparent by reference to a sectional map. That simple description covers the only land so numbered in the whole United States. It is as simple as the street numbering system in Washington, D.C.

A Prairie Quarter Corner in 1903, Iowa
Stone Marker, Mounds, and Pits

If the earth were only flat, if the equipment of those early surveyors had been equal to present-day standards, and if they had been qualified and minded to do uniformly good work, this article would not be necessary. The present-day surveyor's work would be the simple application of science to the retracement of the old lines.

But the earth happens to be other than flat, the compass and chain of the early days were unreliable, and the contractors who surveyed the public lands were not all properly qualified to do the best possible work

with the equipment at hand. Consequently it requires something of a detective to retrace their work.

It was the original intention to make the townships six miles square, bounded by true east and west lines on the south and north sides, and true meridians on the east and west sides. As soon as it became apparent that these conditions were impossible of fulfillment, the specifications were changed to allow for the convergence of meridians. The east and west sides of townships were still to be true meridional lines, the north and south boundaries were to be parallels of latitude, and the sections were to be one mile square, with the excess or deficiency thrown into the western and northern ranges of sections. The shortcomings of men and equipment were realized and rather wide limits of precision were allowed Since no inspection of the surveyor's work was made, the early surveys are found to be very inaccurate in linear measurements, bearings, and actual character of the monuments.

It was the intention of those in authority that full section lines should be straight from corner to corner, with the half-way monument or quarter corner on line and half way. The notes invariably show this to be the case. In practice, if a quarter-corner monument is found to be on line with, and half way between, its adjacent section corners, it is practically certain that repairs have been made by some later surveyor. Such a quarter-corner monument is in all probability not in its proper original location. It was undoubtedly assumed to be lost by some early surveyor and the new corner was established erroneously to give each interested owner equal proportionate parts of the land.

From the very nature of the equipment used in the surveys made from 1785 to 1850, a change of bearing should be expected at each monument, while the recorded distances should not be expected to agree with the actual. For at least 25 years after 1850 the same conditions held true, although not for lack of better instruments.

After 1812 the demand for land became more and more insistent, and to satisfy this demand many untrained deputies were given contracts. There is even evidence of absolute fraud, where the surveys were made only on paper, no monuments having been set and no lines run in the field. However, the majority of the glaring errors can be explained if the surveyor will reconstruct in his mind a true picture of conditions at the time of the original survey.

Consider hostile Indians, wild animals, inadequate supplies, great distances from the base of operations, poor transportation, flooded streams, drought, insect pests, heat of summer, winter cold, unreliable help, dense forests, underbrush, and countless obstacles to progress. Then consider a low rate of pay on a piece basis, a two-rod chain requiring 160 lengths for a mile, an open-sight compass on a Jacob staff, no back sights, local attraction, and unexpected delays. Is it any wonder that the rough half miles of the east and west lines were frequently never measured?

The surveyor today therefore must avail himself of all

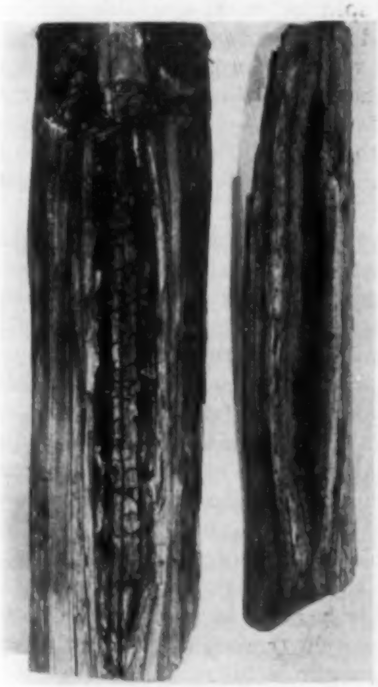
FIG. 1. PRINCIPAL MERIDIANS AND BASE LINES GOVERNING THE PUBLIC LAND SURVEYS OF THE UNITED STATES

recorded information regarding the original survey and the surveyor in order to reconstruct the scene of his work. He must know the instructions under which the work was executed, the time of year, the character of the terrain at the time of the original survey, as much as possible about the other work done by the same surveyor at about the same time, the instruments used, and all the recorded notes and reports. In addition, he must have a good imagination. The recovery and identification of the more ancient of the original monuments is a task requiring patience and skill. The later ones are still in evidence and can be found by the novice.

If a land surveyor were delegated to find the tract previously mentioned, the S.E., S.E., 33, 84, 23, he would go to the records of the original survey to learn by whom and when the original survey was made, and any facts relating to that survey which may be helpful in relocating the corner monuments today. Copies of these notes may be on file in his county courthouse, although the original notes of the older surveys have all been turned over to the state land departments at the various state capitals. The county records are frequently merely abstracts of the original notes.

He will find that the original subdivision survey was made in 1847 by a surveyor whose work is known to be quite irregular in quality. The township lines were run in 1846 by another surveyor whose work is usually good. Some of the corner posts were witnessed by bearing trees, others in the prairie by mounds and pits—quite similar to those shown in the illustration, but still built according to the earlier specification, which required the mound to be raised around the post instead of on one side.

A reading of the old records will give many clues which will be helpful in the restoration of the original monuments, in many cases nearly a century and a quarter old. The surveyor will go next to the county courthouse and examine the survey records to learn what subsequent surveys, if any, have been recorded which refer to the corners needed in the survey of Section 33, 84, 23. He finds city plats, records of surveys in the section, and those surrounding it, which show that in 1870 and later years the original corners were still in evidence. Some have been replaced with stones. The early records rarely show distances found. Apparently these early surveyors were not surprised to find discrepancies ranging from a few feet to hundreds of feet. In some of the later surveys, say in 1890, the records may show distances from monument to monument as found, and in many cases new ties were recorded to aid in quickly relocating the original points. This use of reference ties has been in process of adoption during the last few years.



BLAZE ON SPRUCE TREE, 1883
Forty Years of Overgrowth Removed to Show Original Scribe Marks and Raised Imprint on Overgrowth

After gathering records from public and private sources, the surveyor will go into the field prepared to find the corner monuments needed to locate the S.E., S.E., Sec. 33, 84, 23. At the southeast corner of the tract he finds the intersection of two city streets. The city lots on three sides of the intersection have been laid out with reference to the section corners. City records make the finding of the block corner monuments easy. In fact, the section corner monument itself has been preserved by placing a lamp-hole box and cover over it at the time the street was paved. The original monument has been perpetuated by subsequent users, and a stone has replaced the old stake.

WALNUT STAKE SET IN 1847
Condition in 1928

ORIGINAL LINES AND CORNERS FIX BOUNDARIES

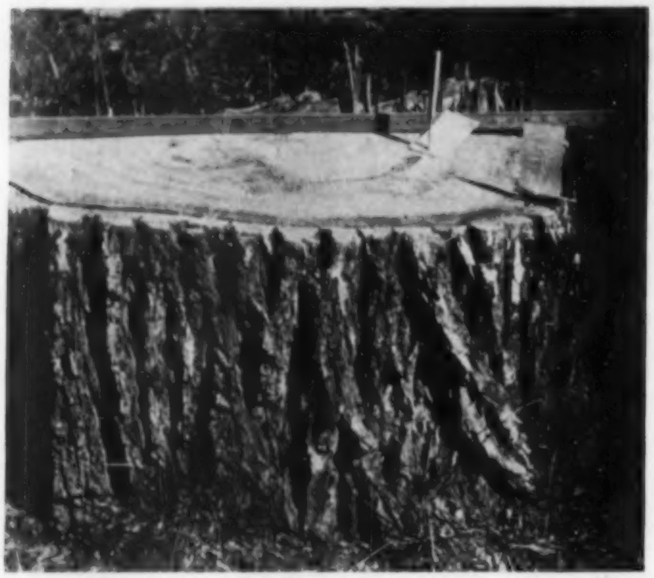
In 1805, Congress passed a very wise law to the effect that boundary lines actually run and marked are the boundary lines of the sections or subdivisions for which they were intended. In this same act, the method of locating boundary lines not "run and marked" was also laid down. Today then we must find the lines "run and marked" and we must follow the rules so wisely laid down in 1805. It is apparent, then, that if the early surveyor was careless or had inferior equipment, the previously mentioned section S.E., S.E., 33, 84, 23 may not contain 40 acres. The Government does not claim that it contains 40 acres but transfers 40 acres, more or less, according to the Government survey.

In 1931, when we come to retrace the original lines and find the original monuments or their successors in the original places, we find highway improvements built along many of the lines. Sewer and water lines have been constructed in the center of the highways. Frequently we can be very positive that the original corner monuments have been destroyed during construction. But the corners are not necessarily lost. Their location has been tied in by improvements constructed while the original corners were still in evidence.

They have been tied in by good surveys locating subsidiary points from the original. Well selected bearing trees are ready to point out the location of the corner a hundred years after the original survey, provided man has not destroyed them.

BLAZED TREES LOCATE OLD CORNERS

A recent survey disclosed a 12-in. pine still living in 1931, which was blazed and marked in 1881, fifty years ago. This tree has grown less than 2-in. in diameter, and if unmolested by man, wind, or fire should be a witness for the stone monument at the corner 100 years from now. Even if blown down or killed by fire, the blaze will show for many years so that it will serve to mark the original spot for a long time. It has served to identify the corner until man has had time to perpetuate it with a stone monument properly tied in to other corners and to a coordinated system tied in to the monuments of the United States and Canada Boundary Survey.



LINE TREE MARKED IN 1847
Elm Stump, Cut in 1930, Showed 83 Rings from Blaze to Bark

In surveying in timbered country in northern Minnesota, where the surveys were made 50 years ago, 88 per cent of the original corners have been identified from original bearing trees, several of which are pictured here—out of 35 corners on 15 miles, 4 are missing. In 1929 a survey of about 35 miles of the state boundary between Wisconsin and Michigan located 70 per cent of the original corners 82 years after they were originally set. This leads to the conclusion that when lines were run and marked in timber, a large percentage should be recoverable today if the timber still stands or even if the stumps remain.

The elm stump illustrated is that of a line tree marked 83 years before it was cut down. The 83 rings are easily counted from the south hack mark to the bark. The north mark, while decayed, still indicates the true nature of the tree, which was described in the original notes as a 16-in. elm on line at 2.65 chains north from the corner. The corner post was entirely obliterated by a changing river channel but with the aid of this line tree it was possible to restore it to its proper place. In this instance, the half mile south of the corner was only 2,459 ft. long instead of the recorded 40 chains, or 2,640 ft.

In timber, a careful search for blazed line trees and bearing trees or their remains is sure to be repaid. Many old bearing trees have been found almost entirely rotted away but with the face of the old blaze still preserved. An illustration shows a 4-in. birch tree marked for a meander corner in 1883. The rotted stub still stands and the old blaze still carries the scribe marks. Another illustration shows this same tree with a white pine bearing tree in the background, also illustrated in detail. The birch probably died in 1883. The pine has grown at least 4 in. in diameter and looks as if it would last for a hundred years. In other cases trees have been almost completely destroyed by fires, yet the blazes are still decipherable or positively identifiable.

A 10-in. diameter hickory bearing tree marked by Uriah Biggs in southeastern Iowa in 1837 was still available as a stump in 1923, the scribe marks still showing the "B.T." mark. An illustration shows the blaze on a spruce tree marked in 1883 for a bearing tree. In 1923, forty years later, the overgrown wood shown was slabbed off to identify the tree. The wood was sound and the original axe and scribe marks remained in perfect preservation. The slab shows the reverse pattern of the original marks in the overgrown wood.

With one or more bearing trees to guide the search, the point of the old stake or post is frequently found, but it will rarely measure up to the dimensions required in the instructions. The point of the original stake, here illustrated, indicates that a post which was required to be 4 in. in diameter in 1847, is only about 2 in. by $1^1/_4$ in. This stake was of walnut. In all probability stakes were made up in the evenings at camp from the easiest splitting wood available nearby, and their points charred in the campfire.

In prairie country, where improvements have not changed the face of nature, it is still possible to find the cross sections of old pits and the holes where the stakes were driven. Even if the wood of the old stake is gone, the hole will still remain, frequently filled with a solid mass of rootlets.

Many young surveyors are too prone to assume a corner lost when in fact it can be identified with certainty. Such men prefer to take proportional measurements to distant corners even when there is unmistakable evidence near at hand to show them the place where the corner monument was. If it is kept in mind that there is probably an angle or a change of bearing at every original corner, and that no two adjacent half miles may be expected to be equal, it is evident that proportional measurements to distant corners will not replace a corner correctly. Of course, if no evidence remains to indicate the probable location of the original mark, everyone will be best satisfied with proportional measurements, but if anyone has any idea where the mark was, it is better to search thoroughly in that place before assuming the corner to be lost.

GOVERNMENT SURVEYS NO LONGER MADE BY CONTRACT

For 125 years, from 1885 to 1910, the original surveys were carried on under the contract system. Since that

Birch Tree Meander Corner and White Pine Bearing Tree
Rotted Birch with Scribe Still Legible, at Left; White Pine with Slab Removed, at Right

time they have been performed by the U.S. Cadastral Engineers. From 1910 on, all public lands not previously surveyed have been or will be surveyed by competent surveyors. It happens that supposedly only the most worthless land remains to be surveyed. Naturally, the demand for surveys was most insistent in connection with the best land.

There seems to be a real need for a book of instructions for the resurvey of Government land lines, with full extracts of the essential instructions used at the time the original surveys were made. What is needed is a history of the rectangular system of surveying brought down to date. The 1869 Report of the General Land Office contains such a history, but even that report gives only the current practice, which is useful in retracing the surveys of about that time but misleading in the retracing of surveys made much earlier.

Next in importance to a knowledge of the actual conditions under which the original work was done, is the ability to apply that knowledge in the field. Almost uncanny powers of observation and untiring thoroughness are consistently rewarded by success.

"LOST" CORNERS MAY BE ONLY HIDDEN

The inexperienced surveyor invariably upsets long settled ownership by assuming corners lost which are only hidden to him because he has not equipped himself with all possible historical helps. His powers of observation are not trained by past successes to show him the signs pointing to the actual location of the original corner. In settled parts of the country such signs are many. They are written in fence lines, building lines, center lines of roads, hedges, rows of trees, and subordinate property lines. Digging frequently unearths the needed clues. Why should a surveyor measure to distant corners when any judge will rule that these local clues determine the boundary points?

For 75 years, in Iowa, Illinois, Wisconsin, and Minnesota, and in parts of the surrounding states, surveyors have been digging for corners located in highways. When found, these monuments have been used for the purpose of the moment and then buried. Is it not time that such monuments should be tied in to modern surveys so that they need not be dug up to ascertain their position? At a recent surveying conference at Ames, it was agreed that a corner once identified should be so well tied in and recorded that future users need waste no time in its recovery. At that conference it was also agreed that stone monuments will soon be out of date because ferrous markers can be so much more easily identified and recovered by the use of a simple radio prospecting apparatus, which will sing out when it approaches the monument.

LINES OF OCCUPATION AND ADVERSE POSSESSION

Nothing in this article should be interpreted to mean that the recovery of the original corners can really affect the ownership of property long held adversely to their showing. The courts have the same regard for long settled occupation by individuals that they have for the lines as originally run and marked. The surveyor will, upon finding the original lines, explain their relationship to present occupation and generally secure compliance with the lines when the occupation of adjoining owners has been friendly, but in ignorance of the true position. It is important to keep in mind that long occupation by one individual adverse to another may make useless the surveyor's efforts in finding the original corners.

In the case of the public, adverse possession by individuals usually will not hold, and highways can be placed in their proper position upon the recovery of the true original lines. In the public-land states, it has long been the custom to lay out highways bordering the rectangular sections of land. This explains the checkerboard system of road location so common in those states. A four-rod strip was originally reserved for road purposes, the fee title being held by the landowner and an easement vested in the public.

To recover original Government survey corners today, the surveyor must be a detective equipped with scientific instruments and historical knowledge. He must have a profound belief that hard work and thorough searching will be rewarded. He must be optimistic in the belief that the corners were actually marked and that something someone did at the time or subsequently will show him the place where the corner was, if not parts of the original monument itself.

Choosing Filtering Materials

For Water and Sewage Works

FOR somewhat over six years the Committee on Filtering Materials for Water and Sewage Works has been active, three members having been appointed in May 1925 and the two others in the following year. This committee has relentlessly pursued its work of research and experiment and now approaches its objective—the preparation of two Manuals of Engineering Practice. Progress reports of the work done by the committee have appeared in the publications of the Society from time to time.

General conclusions of the committee were embodied in the progress report and its appendix read on October 8 before the Sanitary Engineering Division at the Society's St. Paul Meeting. This report by Mr. Stanley's committee is here presented in abstract. The appendix, by Mr. Armstrong, has also been abstracted to round out the description of the valuable work which has been accomplished by this committee.

Division Committee Submits Progress Report

SELECTION of the best type of filtering material as between slag, crushed stone, gravel, and the like, involves controversial questions such as the effect of roughness or smoothness, the effect of angular or rounded particles, and similar factors, on efficiency of operation, including the ability of a filter to unload. As yet there are insufficient comparative operating data to permit a definite determination of the relative effect of these general characteristics of the various types of material which may be used for trickling filter media. Examples of both successful and unsuccessful use can be found for each type of material.

Thus more definite data on trickling filter loading must be obtained, particularly with reference to the comparative influences of sewage strength and composition, the fauna and flora of the filter bed, and the sizing of the filtering medium, before an exact basis can be set up for comparing the relative merits and economies of various types of filter materials.

The sodium sulfate soundness test has been set up as the most practical determination of probable durability, and a test procedure has been developed based on an extended investigation, including a large number of laboratory tests. It is believed that this test is a practical method for comparing several proposed materials. It makes it possible for an engineer to specify a minimum soundness rating or to compare two or more materials on the basis of their respective soundness ratings.

As yet there are insufficient data showing the relation between the results of soundness tests and actual deterioration under service conditions, to definitely fix the allowable limits of breaking down by the soundness test. No exact quantitative method has yet been devised for measuring the actual deleterious effect of fines on filter operation.

In general, a satisfactory filtering material, as to durability, should have a soundness rating of not less than 80. However, each specific case must be determined after a consideration of all the local factors, particularly the item of comparative costs. In some cases it may be advisable to use larger material and to remove fines more carefully, thus providing some allowance for breaking down. Also the lower portions of the filter bed may be constructed of less durable local material, and the top 12 to 15 in. filled with more expensive and more durable material shipped to the site.

The amount of dirt and fines and the uniformity of the filtering material as placed in a trickling filter are most important. It is probable that many of the difficulties attributed to deterioration of the medium in existing plants are actually due to improper preparation of the material as originally placed.

Special emphasis has been placed on screening and on the cleaning of the filtering material during its production. The extent of allowable fines has been placed at 5 per cent of the total quantity of material. Improper handling and placing might easily cause this 5 per cent to be segregated into a relatively small part of the filter bed, which might be objectionable, particularly if it were placed near the surface. Thus, handling and placing methods should be carefully considered.

Certain phases of the problem of selection and preparation of trickling filter material cannot be definitely determined until a more rational basis has been set up as to the allowable loadings for various characteristics of the filter media and the applied sewage.

The factors involved and their relative relationships are quite complex, and as yet no satisfactory analysis has been developed. The relative influence of the size, uniformity of size, and character of the filter media as compared to the influence of other factors on the safe loading of trickling filters is not known. Most of the data relating to the operation of existing trickling filters are deficient in some important items so that accurate analysis is difficult or impossible. Also, many existing filters are operating inefficiently because of improper filter materials, unsatisfactory as to cleanness and relative proportions of finer materials.

The relative importance of the trickling filter for sewage treatment warrants a more definite attempt to determine the relative importance of the many factors which control efficiency of operation. Such effort will require collection and analysis of data and coordination of numerous investigations, probably covering a considerable period. A committee of the Sanitary Engineering Division would be the proper agency for such work.

Fine grained filter materials for sewage work were studied, including sand for intermittent sand filters

and for sludge beds. Data collected indicate that there are some 400 municipal installations of intermittent sand filters in the United States, many of which are operating very inefficiently. The primary causes for the poor results in the operation of intermittent sand filters relate either to improper material placed in the filter bed at the time of construction or to deterioration of the bed because of insufficient attention or improper loadings.

There is a definite place for the use of intermittent sand filters, particularly for small sewage disposal plants and as a finishing process where a high degree of treatment is desirable. It is likely that a greater need will develop as the demand for a high degree of sewage treatment increases.

Filter beds should be designed for loadings which are related to the character of the available material rather than for a specific loading which would require a more expensive material. The loading which can be applied to a sand filter is related to the strength and character of the applied sewage, the effective size and uniformity coefficient of the sand, and the care exercised in operating the filter.

Safe loadings are suggested, based on a careful analysis of the results of experimental work, particularly on the Massachusetts and the Columbus experiments. These are related to the organic strength of the sewage, the degree of pretreatment, and the effective size and uniformity coefficient of the sand in the filter bed.

During the past year much interest has developed in the experimental work relating to filter sand for water filters. Some difference of opinion exists among waterworks engineers as to the value of tests made by small glass tube filters. However, this committee believes that there is sufficient evidence that these results are of value to warrant the making of the tests. Larger test filter units obviously would give more valuable results. However, it is impractical to obtain the extended operation of such experimental units. Later the results of tests on small glass filters can be verified by relatively few experiments on larger units.

During the past two or more years the results of a number of experimental tests have been studied, and a revised program of test work has been developed. This program is just getting under way, with the cooperation of the filtration departments of 16 or more cities. The principal objectives of these tests include the determination of the relationship of filtration and sand sizes with reference to the ability of the filters to prevent passage of floc; the length of filter runs, together with the effect of temperature on the length of such runs; and the relation of sand sizes to filter washing, including optimum rates of applying wash water and the effect of temperature on wash-water rates. As secondary objectives, it is expected that the experimental work will secure data showing the relation of wash-water rate and sand expansion; the depth and quantity of floc penetrating the filter bed; the extent of hydraulic grading of the sand by the wash water; the effect of temperature on sand rise; and the effects of unusual local conditions such as the organic content of water, its alkalinity, turbidity, color, iron manganese content, and the like, on the operation of filters.

Detailed instructions have been sent to the various cooperating cities to insure uniformity of procedure in the several series of experiments. It is believed that this program of experimental work should extent over at least one year in order to obtain the effect of seasonal variation in the character of the applied water on the several series of experiments.

Final reports have been completed covering two phases of the work of the committee. These reports, with some minor changes, are expected to be used as Manuals of Engineering Practice covering: *Filtering Materials for Trickling Filters,* and *Fine Grained Filtering Materials for Sewage Works.*

Two other items relating to filter materials remain incomplete. These are the relation between filter media and safe loadings for trickling filters, and the proper use of filter sand for water filters. Both of those items include consideration of the character of the applied sewage or water and the effects of environmental factors, particularly temperature, on the operation of the filter. Definite consideration should be given to trickling filter loadings, including sufficient study to develop at least the fundamental considerations and the relative importance of various factors. It is probable that considerable time will be required before final and definite conclusions can be developed relating to trickling filter loadings.

Much the same situation exists with reference to filter sand for water works. The present program of experimental work should be continued to a point where the apparent relation between sand sizes and the many other factors is established in so far as practicable with small experimental filters.

William E. Stanley, *Chairman*

James W. Armstrong — George B. Gascoigne
W. H. Dittoe — N. T. Veatch

Cooperative Filter Sand Experiments

During the years 1928 and 1929, fourteen different cities agreed to cooperate in conducting a series of tests for the purpose of determining the best size and depth of filter sand. Of this number, six actually did considerable work in carrying on the experiments. The results indicated very clearly that the effort was worth while and is worth continuing, but too much was undertaken with a limited equipment, and sufficient data for drawing general conclusions were not secured.

During the year 1930 no work was done by any of the cooperating cities except Baltimore, where a fairly extensive series of tests was undertaken. The results of these tests were summed up in a paper which was presented at the Pittsburgh meeting of the American Water Works Association. These results pointed conclusively to the fact that further experiments were justified.

At the meeting of the Committee on Filtering Materials, held in Chicago on August 22 of this year, it was decided to seek the further cooperation of the cities who had helped, and to enlist the services of a number of others in running a new set of tests in an effort to try to secure the necessary data for concluding the work of the committee within another year.

PRELIMINARY TESTS WITH GLASS TUBE FILTERS

The first set of experiments was conducted by Baltimore, Chicago, Denver, Providence, Sacramento, and

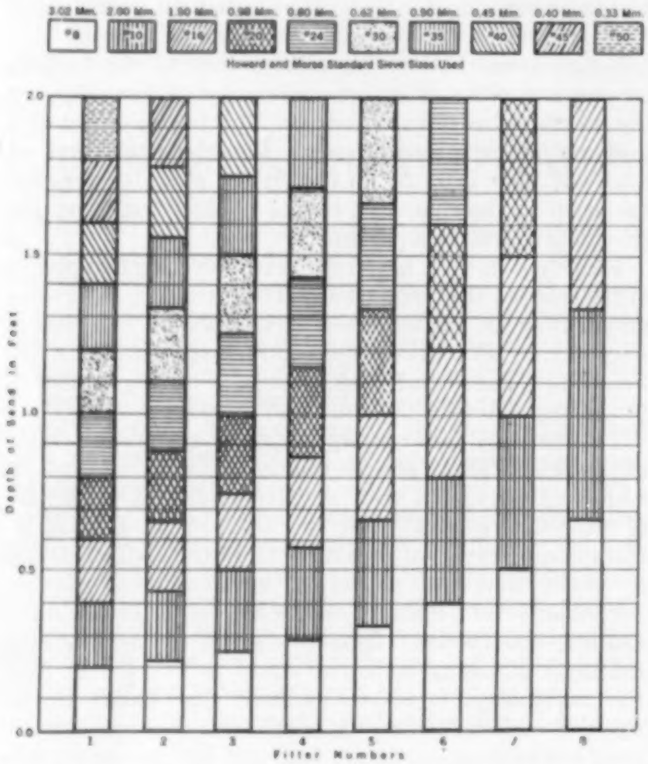


FIG. 1. DEPTH AND GRADING OF SAND USED IN EXPERIMENTAL GLASS FILTERS

St. Louis. Seven small glass filters were used, one of which, equipped with sand taken from one of the regular plant filters, was to be used as a control unit in order to compare the results of the large and small units. The other filters were filled with sand varying in size and depth. Results of the first series of tests revealed a decided similarity in performance in different cities with sand of the same size, although there was a great difference in the length of runs, apparently due to the difference in the kind of water treated. Owing to the fact that an effort was made to determine both depth and size in the same series of tests, a sufficient range of facts could not be secured for drawing general conclusions.

Work carried on during 1930, while limited as to locality, covered eight different sizes of sand, ranging from very fine to very coarse. A number of interesting and new facts were observed that seemed to warrant the continuing of similar experiments in other places and with other kinds of water.

The work of the committee, as carried on up to the present time, is suggestive of some rather interesting possibilities. They seem to indicate that most of the trouble from mud deposits that causes so much difficulty to filter operators is due to two things: first, the use of a filter sand that is too fine; and second, the application of wash water at too low a rate to properly clean the filter beds. They also indicate that possibly the choice of a filter sand may depend on its ability to be cleaned readily during the washing period. While the results were not conclusive, they were valuable enough to warrant the continuance of the work.

A YEAR'S COOPERATIVE TESTS ASSURED

An entirely new program has now been outlined. It contemplates a series of experiments to be conducted with eight different 2-in. glass tube filters, each of which will contain a different size and grading of sand. The range is sufficiently wide to include every size that is practical to use in the filtration of water (Fig. 1). With this range it should be possible to draw definite conclusions and to establish limits within which the best operating results may be expected for different kinds of water. Very careful experiments are also to be conducted in reference to the rates of application of wash water, in an effort to determine a rate best suited for cleansing various sizes of sand. It is expected that, with different waters, requirements for sand may vary considerably, and with this thought in mind an effort has been made to secure the cooperation of cities in different parts of the country. The details of this work have been outlined and will be sent to each cooperating city.

When it was learned that new experiments were to be undertaken, representatives from a number of cities came forward to volunteer their cooperation in the work and appeared to be very much interested. Some of the increased interest has been occasioned by the fact that in some cities much trouble has been experienced with short filter runs and mud deposits in the filter beds.

Negotiations are under way with the following cities to enlist their cooperation in the experiments:

Chicago	Denver	Richmond	Dallas
St. Louis	Springfield	Sacramento	Baltimore
Omaha	Tulsa	Washington	Providence
Racine	Toronto	Kansas City	Quincy

Some of these cities have already signified their willingness to undertake the work. A few are hesitating on account of the amount of labor involved. Instructions and blue prints of the layout of the experimental filters have been sent to most of the cities, and sand is now being rescreened and prepared for sending out.

COOPERATION WITH AMERICAN WATER WORKS ASSOCIATION

Last May, the Purification Division of the American Water Works Association at the Pittsburgh meeting appointed a Committee on Filtering Materials, whose duties would be very similar to those of the committee of the American Society of Civil Engineers. They are to cooperate with our committee in carrying out the new program as outlined above, and the committee is to cooperate with them in every way to make the work a success. In order to have a contact member on these committees I have also accepted appointment to the American Water Works Association committee.

JAMES W. ARMSTRONG

Trickling Filter Loadings

Effect on Oxygen Demand Reduction

By J. A. Childs, M. Am. Soc. C.E.
and George J. Schroepfer, Jun. Am. Soc. C.E.

Chief Engineer and Assistant Engineer, Metropolitan Drainage Commission of Minneapolis and St. Paul, St. Paul

Data from 15 trickling filter plants used in the treatment of sewage in the United States are here analyzed and correlated. The effect of increasing the rate of application and varying the strengths of sewage on the reduction of bio-chemical oxygen demand in the effluent is the major result. As far as they extend, the data seem to indicate that, in any particular filter, neither the strength of the sewage nor its rate of application upon the filter materially influences the per cent reduction in bio-chemical oxygen demand. Read before the Sanitary Division at the Society's St. Paul Meeting on October 8, this article gives results from available data and indicates the desirability of extending the study to definitely overloaded filters.

Engineers who are responsible for the design of any structure are desirous of having as definite information as possible relative to strengths of materials to be used and the loads to which the structure may be subjected. In a sewage treatment plant the load to be carried is measured by the volume and strength of the sewage treated, and the reduction in strength is an index of the effectiveness of the process. When considering the design of a trickling filter for the treatment of sewage, the sanitary engineer endeavors to build at a minimum cost a structure which will be most effective in reducing the strength of the sewage which may be passed through it.

In order to arrive at such a design many factors must be considered. Unfortunately, because of lack of sufficient and reliable data, properly correlated, the average engineer does not possess all the information which he should have when considering such a problem. He is therefore forced to use higher safety factors than would be warranted if sufficient information were available.

It is obvious that the efficiencies of trickling filters are influenced to a greater or lesser degree by many local factors, among which are: sewage characteristics; method of application; depth of filter bed; temperature; size, shape, and kind of filtering material; dosing and rest periods; and the type of under-drainage system. In presenting the data which follow, collected by the Metropolitan Drainage Commission of Minneapolis and St. Paul in the course of its investigations, all influencing factors except strength (as measured by the oxygen demand test) and rates of application have been disregarded as being peculiar to a particular filter.

While several methods may be used in measuring the improvement effected by sewage treatment, the bio-chemical oxygen demand determination, commonly known as the oxygen demand test, has been selected as a rational means of comparing the improvements accomplished at various plants. In *Standard Methods of Water Analysis*, published by the American Public Health Association, it is stated that "the bio-chemical oxygen demand [B.O.D.] of a sewage, effluent, polluted water, or industrial waste is the oxygen in parts per million required during stabilization of its organic matter by aerobic bacterial action." It is stated in the U.S. Public Health Service Bulletin No. 132 that "the test appears to furnish by far the most valuable information as to the behavior of the plants and the efficiency of the various devices used in sewage purification. . . . The oxygen demand determination has the decided advantage that it is applicable to sewage in all stages of purification, and the information that it furnishes can be used independently of the results of other determinations."

Information relative to filter operation has been obtained from a total of 15 plants located in seven states, from Massachusetts and Minnesota in the north to Texas in the south. The data are based upon the analysis of composite 24-hour samples, with the exception of that from Madison, where the sampling period extended from 7 a.m. to 4 p.m. The values presented cover operating runs from a minimum of one day in some cases to one year in others.

In every plant the distribution is by means of nozzles. The analytical data used in the tables and in preparing the charts, and upon which the per cent reductions in oxygen demand have been computed, are, with the exception of the Baltimore data, in all cases the five-day B.O.D. of the filter influents and the effluents of the final settling tanks, where such are used. The Baltimore data are on a one-day 37-deg. cent. basis. Conversion of these data to a five-day 20-deg. cent. basis would have no effect on the efficiencies, which are measured by the slopes of the curves. Although adequate final sedimentation will usually improve the quality of the plant effluent, its use is but one of the factors of local consideration, which does not materially influence the final deductions.

In Fig. 1 is plotted the relation between the average per cent reduction in five-day oxygen demand and rates of application computed from data secured. The data cover rates of application from a minimum of 0.39 million gal. per acre per day to a maximum of 4.19 million gal. per acre per day, with oxygen demand reductions from as low as 30 per cent to as high as 97.5 per cent. The flows used in expressing the rates were the average daily flows during the period of the run.

The horizontal lines in Fig. 1 represent the average oxygen demand reduction computed from the data tabulated; the vertical distances from the horizontal line to the points plotted for the individual runs represent the variations from the average. It will be observed that in most instances the points representing the in-

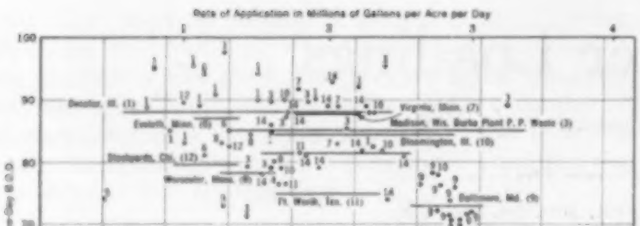


FIG. 1. TRICKLING FILTER PERFORMANCE
Relation Between Rate of Application and the Average Per Cent Reduction in Five-Day Bio-Chemical Oxygen Demand

dividual runs at higher rates of application are above, rather than below, the average line.

The data from any individual plant indicate that higher rates of application did not decrease the per cent reduction in oxygen demand at that plant. If this were the case, the curve representing the per cent reduction for each plant would have a downward trend as the rate of application is increased. This is not indicated by the data obtained. Unfortunately, the rates of application at most of the plants have not varied sufficiently, especially as regards the higher rates, so as to indicate the maximum rate, to exceed which would result in a decrease in the per cent reduction in oxygen demand.

Results of tests studied indicate that the lower percentages in some of the tests were not due to the sewage being stronger at that particular time. The reverse was often the case. These data appear to indicate that within the practical limits of operation, the rate of application does not influence the per cent reduction in five-day B.O.D. which may be accomplished by a particular filter.

A chart, Fig. 2, has been prepared to show the relationship between the strength of the filter influent and the reduction accomplished, both being in terms of five-day B.O.D. The slopes of the diagonal lines are measures of the per cent reduction in oxygen demand, which may be determined by dividing the ordinates at any particular point on the line by the abscissa at that point. Data from the various plants cover a wide range in filter influent strengths, the variation being from 37 parts per million (p.p.m.) to 1,253 p.p.m. of five-day B.O.D.

While the oxygen demand reduction in per cent at the different plants is by no means the same, the per cent reduction in oxygen demand by the filter treatment at any particular plant does not appear to have been adversely influenced, even when the strength of the filter influent was increased several times. At none of the plants was there a falling off in per cent reductions in oxygen demand at higher strengths.

There is no indication, within the limits for which data have been obtained, that the per cent reduction of five-day B.O.D. is reduced by applying sewage of greater strengths to the filters.

Filter loadings must necessarily take into account both strength and rate of application. In Fig. 3, the loadings and reduction, both expressed in terms of pounds of five-day B.O.D. per square foot of filter surface per day,

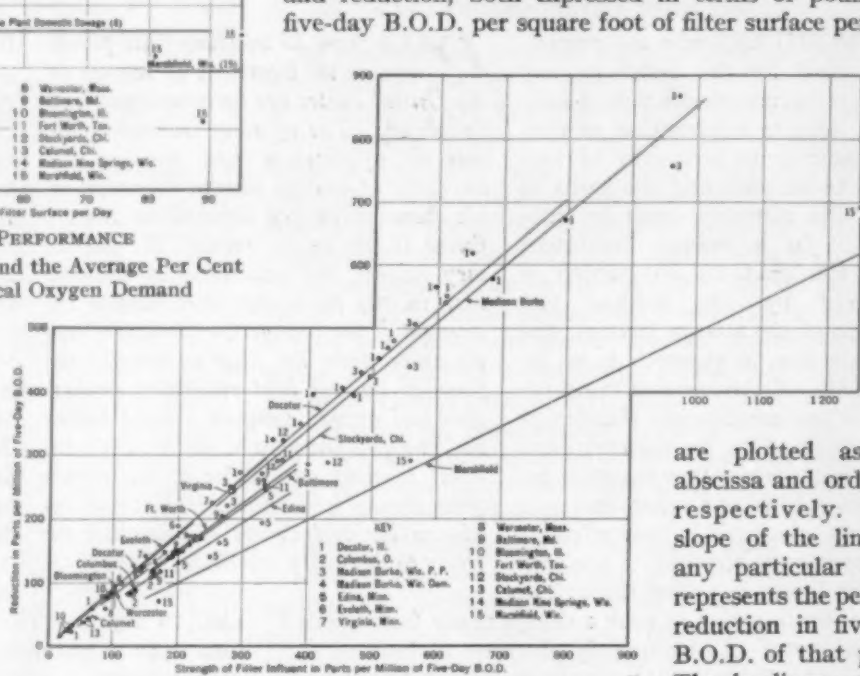


FIG. 2. RELATION BETWEEN THE FIVE-DAY BIO-CHEMICAL OXYGEN DEMAND OF THE INFLUENT AND THE REDUCTION ACCOMPLISHED BY THE FILTER

are plotted as the abscissa and ordinate, respectively. The slope of the line for any particular plant represents the per cent reduction in five-day B.O.D. of that plant. The loadings cover a range up to about 0.22 lb. of five-day B.O.D. per square foot of filter surface per day, corresponding to a population equivalent loading of nearly 60,000 per acre. Here again, as in the previous charts, there is no indication that the per cent reduction in oxygen demand of any particular filter is reduced by increasing the loading, at least within the range covered by these data. At only one plant, Decatur, was there evidence presented that a limit in the filter loading had been reached. This was indicated by a falling off in nitrification.

In Fig. 4, the rate of application has been adjusted to a filter influent strength of 140 p.p.m. of five-day B.O.D., which is the estimated filter influent strength which might be expected should a trickling filter plant be used for the treatment of the sewage from Minneapolis and St. Paul. The rate of application in gallons per square foot of filter surface per day has been plotted as the abscissa, and the reduction in pounds of five-day B.O.D. per square foot of filter surface per day as the ordinate. This curve indicates that the reduction in oxygen demand varies directly with the rate of application.

CONCLUSIONS SUMMARIZED

Provided there is no change in other influencing factors, these data indicate that:

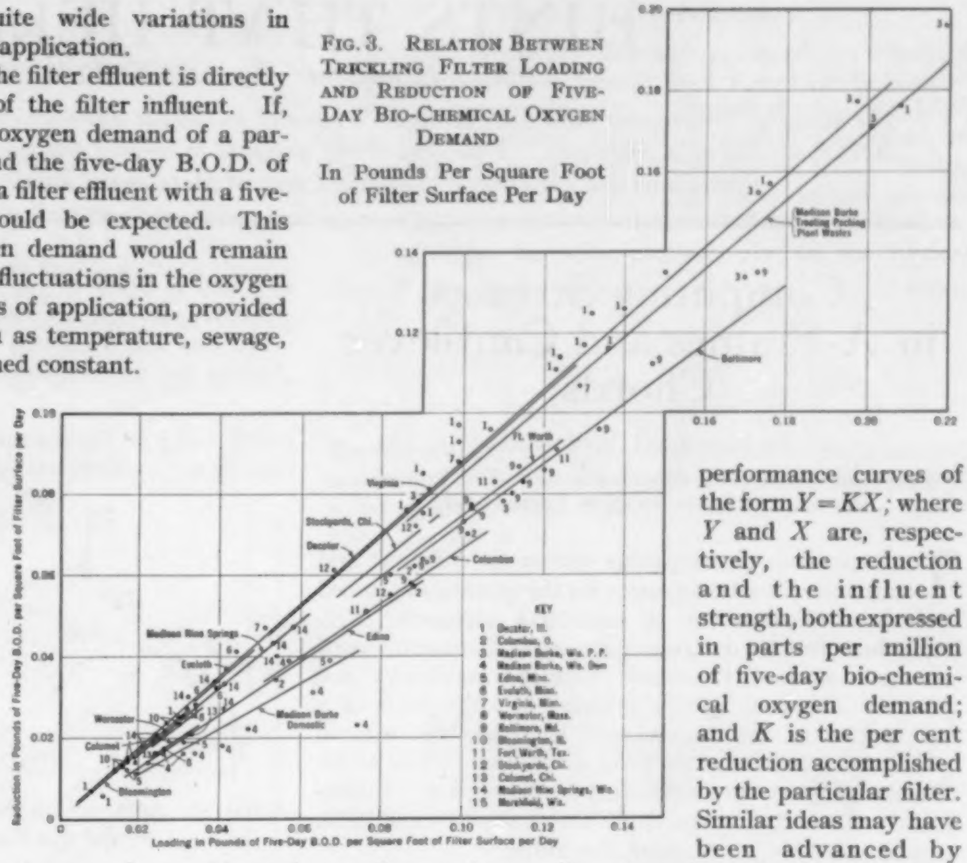
1. The per cent reduction in oxygen demand of any particular trickling filter is not, within reasonable limits,

materially influenced by quite wide variations in strengths of sewage or rates of application.

2. The oxygen demand of the filter effluent is directly proportional to the strength of the filter influent. If, for example, the reduction in oxygen demand of a particular filter is 80 per cent, and the five-day B.O.D. of the filter influent is 200 p.p.m., a filter effluent with a five-day B.O.D. of 40 p.p.m. would be expected. This percentage reduction in oxygen demand would remain fairly constant over quite wide fluctuations in the oxygen demand of the influent or rates of application, provided other influencing factors—such as temperature, sewage, or filter characteristics—remained constant.

Fig. 3. Relation Between Trickling Filter Loading and Reduction of Five-Day Bio-Chemical Oxygen Demand

In Pounds Per Square Foot of Filter Surface Per Day



It should not be inferred that the per cent reduction in oxygen demand of a filter will remain constant regardless of the increases in strength or rates of application. Obviously there must be a loading beyond which the per cent reduction will decrease. Data indicative of the effect of increased loadings, as well as the possible influencing and controlling effects of the other factors, are of much importance to engineers and plant operators.

In an article in *Engineering News-Record* of February 7, 1924, C. E. Keefer, M. Am. Soc. C.E., Principal Assistant to the Sewerage Engineer, Department of Public Works, Baltimore, discusses the operating results in that city from 1915 to 1922. He suggests the possibility of filters having normal performance curves of the form $Y = KX$; where Y and X are, respectively, the reduction and the influent strength, both expressed in parts per million of five-day bio-chemical oxygen demand; and K is the per cent reduction accomplished by the particular filter. Similar ideas may have been advanced by others, but Mr. Keefer's article is the only one which has come to our attention.

In presenting these data, it should be clearly understood that we are not drawing conclusions but are merely pointing out what the data seem to indicate. These data have been presented with the hope that they will be supplemented by material available to other investigators, not only as to the influence of strength and rates of application, but also as to the other factors which have been enumerated in the opening paragraphs.

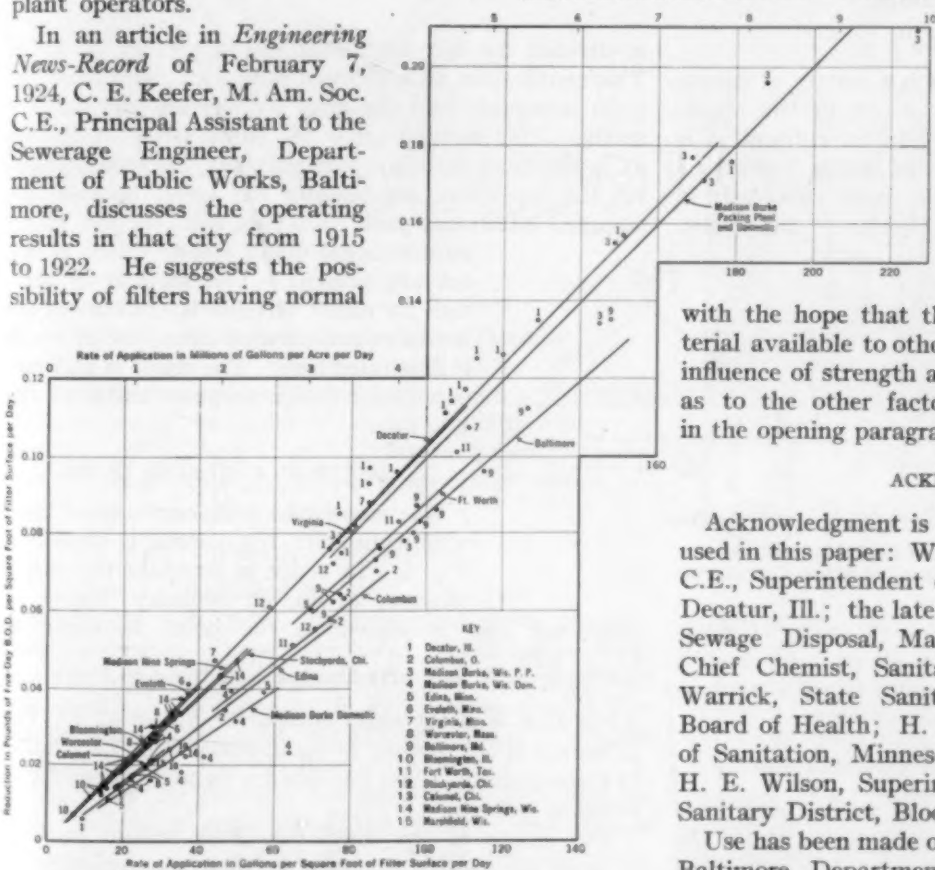


Fig. 4. Relation Between Reduction of Five-Day Bio-Chemical Oxygen Demand Accomplished by the Filter and the Rate of Application

Adjusted to a Strength of 140 P.p.m. of Five-Day Bio-Chemical Oxygen Demand

ACKNOWLEDGMENTS

Acknowledgment is due the following for information used in this paper: W. D. Hatfield, Assoc. M. Am. Soc. C.E., Superintendent of the Decatur Sanitary District, Decatur, Ill.; the late J. W. Mackin, Superintendent of Sewage Disposal, Madison, Wis.; F. W. Mohlman, Chief Chemist, Sanitary District of Chicago; L. F. Warrick, State Sanitary Engineer, Wisconsin State Board of Health; H. A. Whittaker, Director, Division of Sanitation, Minnesota Department of Health; and H. E. Wilson, Superintendent of Bloomington-Normal Sanitary District, Bloomington, Ill.

Use has been made of data from the 1927 report of the Baltimore Department of Sewers, from the annual reports of the City of Worcester, from Bulletin No. 132 of the U.S. Public Health Service, from Folwell's 1929 edition of *Sewerage*, and from the Transactions of the Society.

HINTS THAT HELP

Today's Expedient—Tomorrow's Rule

The minutiae of everyday experience comprise a store of knowledge upon which we depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from young and old alike, should afford general pleasure not unmixed with profit.

Computing Stresses in A-Frames and Cantilever Chords

By Harold S. Woodward

Associate Member American Society of Civil Engineers
Structural Engineer, New Rochelle, N.Y.

The problem of computing stresses in A-frames and cantilever chords of trusses for the framing of pitched roofs is a common one to structural engineers. Perhaps these frames or trusses are most frequently used on small wooden structures such as residences and garages. However, in the framing of large roofs of a complicated nature the engineer is invariably required to use the A-frame in one form or another. The architect naturally desires a maximum in room space. Consequently the ceiling is apt to be above the eaves with no support possible at or near the ridge.

Problems of Design

While the design of these frames is a matter of simple mechanics, there is sometimes a doubt in the minds of some as to the exact solution. In an A-frame it is desirable to place the tie as low as ceiling conditions permit, because the lower it is the more effectively it acts, and the more economical becomes the frame.

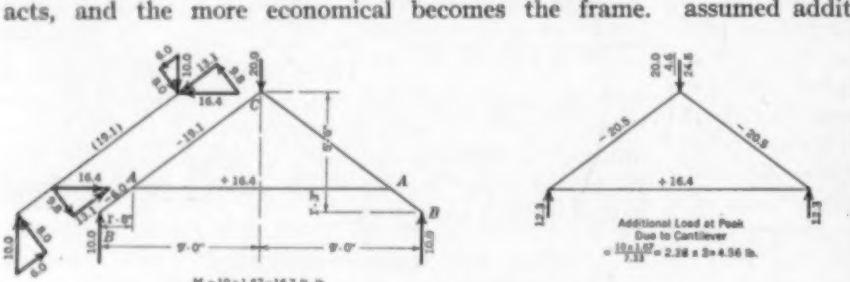


Fig. 1. Roof Truss with Tie Above Supports
(*a*) Exact Method of Calculating Stresses
(*b*) Approximate Method of Stress Calculation

In any case, where the tie is above the point of intersection of the support and the top chord, a moment is induced in the top chord, this moment being at a maximum at the tie.

An Approximate Method of Computation

It should be remembered that, in such a case as is shown in Fig. 1(*a*), the same moment occurs above the tie and decreases to zero at the peak. The top chord should therefore be designed both for bending and for direct stresses. In this case the moment will be 16.7 ft-lb., and the direct compression, 19.1. It can be seen that the direct stress is at a maximum above the tie, and is equal to the sum of the components of the reaction and the tie, which act parallel to AC.

In Fig. 1(*b*) is shown an approximate method of obtaining the direct stresses at once. The moment at A

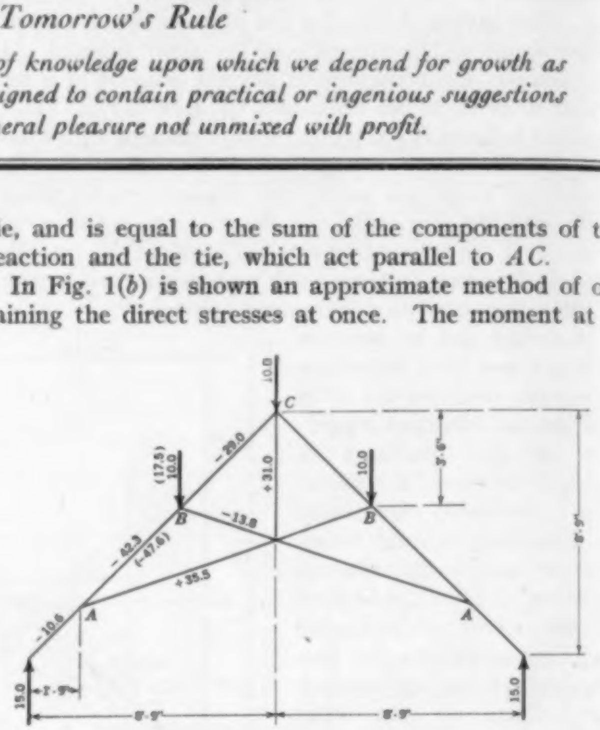


Fig. 2. Approximate Method of Stress Calculation Applied to a Cantilevered Scissors Truss

is divided by the horizontal distance from A to C. This result gives an additional peak load; and from the total new peak load the axial stresses are obtained directly. This method gives the same stress in the tie as is obtained by exact computation, but the stresses for the top chord are slightly too large, because the assumed additional peak load puts into the top chord an additional direct stress, which is not actually present. This method of solution for direct stresses is convenient for the more complicated cases, one of which is illustrated here. The result is accurate enough for design purposes and is on the safe side.

Computing a Scissors Truss

The case of an ordinary scissors truss with cantilever top chords is shown in Fig. 2. In order to compute the direct stresses, as in an ordinary truss, an additional load is placed on the point B, equal to $\dfrac{15 \times 1.75}{3.5} = 7.5$. By this method the direct stress in AB is 47.6, while by exact computation it is 42.3. The difference of 5.3 is equal to the component of 7.5 parallel to the top chord. The top chord is figured for combined stress as before.

The length of the cantilever chord should be kept as small as possible, not only because the members are more economical but because of the deflection of the cantilever. The deflection would result in a horizontal push on the columns or walls and might result in masonry cracks.

Graphical Spacing of Stirrups in Concrete Beams

By ODD ALBERT

STRUCTURAL ENGINEER, EAST ORANGE, N.J.

FORMERLY PROFESSOR IN MATHEMATICS AT WEST COLLEGE, SWEDEN

IF the unit shear in a concrete beam is more than is allowable, then web reinforcement must be resorted to. That part of the shear area which requires the web reinforcement can be plotted without much difficulty. Whether bent up bars or stirrups are used, the number required is easily computed.

It is obvious that the shear area must be divided into as many equal parts as there are rods required, and that the rods must be placed at the center of gravity of each part. In order to divide an area—either a triangle, called Case 1, or a trapezoid, called Case 2—the following graphical solutions are given, which are based on correct derivations.

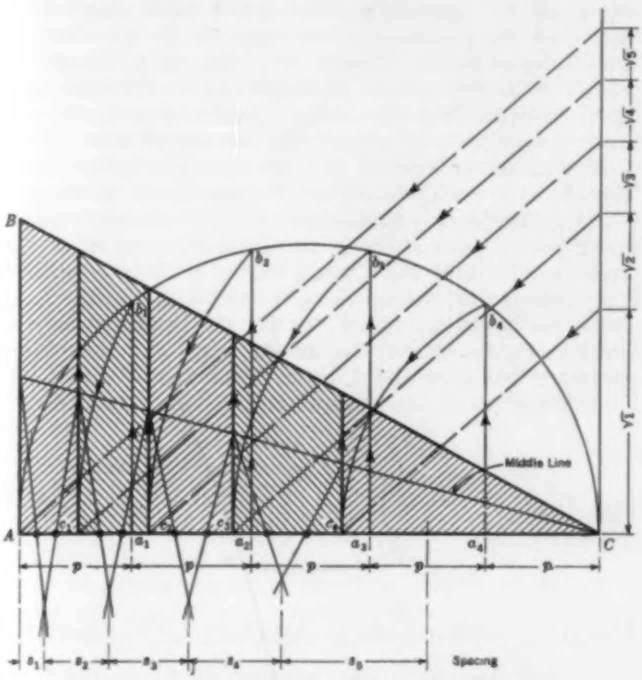


FIG. 1. SHEAR AREA SHAPED LIKE A TRIANGLE

TWO SOLUTIONS FOR CASE 1

In Case 1, illustrated by Fig. 1, in order to divide the triangle ABC into, say, five equal parts, two different constructions are given here. In the first method, divide the base AC into five equal parts, p; then find the vertical projections, b_1, b_2, b_3...on the circle. The verticals from the circular projections, c_1, c_2, c_3..., on the base divide the triangle into equal parts.

To solve the problem by another method, plot on any convenient scale along the vertical from C the values, $\sqrt{1}$, $\sqrt{2}$, $\sqrt{3}$, ... Connect the last point with A and draw lines from the other points parallel with this line to intersect the base line at c_1, c_2, c_3, ... The verticals from these points divide the triangle into equal parts.

TWO SOLUTIONS FOR CASE 2

In Case 2, where the shear area is shaped as a trapezoid (Fig. 2), let $ABCD$ represent the trapezoid to be divided into, say, four equal parts. Complete the triangle ABC; draw the half circle; project E through a circular arc on the circle at b_4; and locate the vertical b_4a_4. Divide the distance $A\,a_4$ into four equal parts, p, and proceed as in Case 1.

To solve by the other method, plot on the vertical from C the points $\sqrt{x}$, $\sqrt{x-1}$, $\sqrt{x-2}$, . . . , where

$$x = \frac{n}{1 - \left(\frac{v_1}{v_2}\right)^2}$$

To compute x, let n be the number of rods needed, and v_1 and v_2 be the shear values to the right and left, v_1 being always less than v_2. Then,

$$\text{for } n = 4$$
$$v_1 = 50, \text{ and}$$
$$v_2 = 100, \text{ we get}$$

$$x = \frac{4}{1 - \frac{1}{4}} = 5.33$$

Then the distances along the vertical line from C will be $\sqrt{1.33}$, $\sqrt{2.33}$, $\sqrt{3.33}$ . . . . Draw inclined parallel lines to intersect AC, as before. If the construction is correct, then the last line should intersect AC at E.

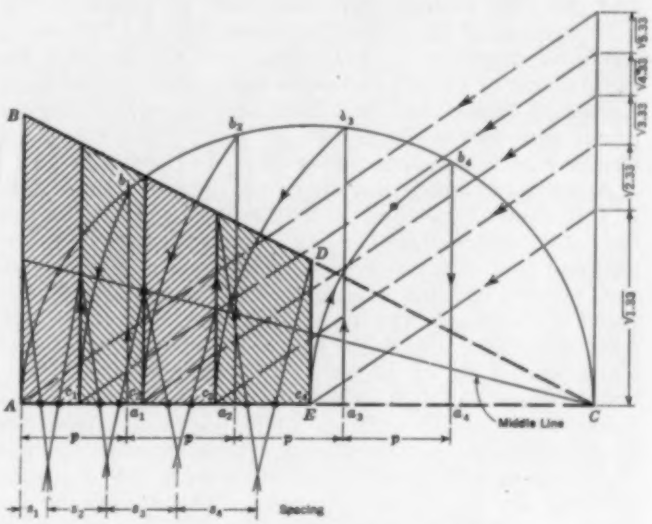


FIG. 2. SHEAR AREA SHAPED LIKE A TRAPEZOID

Attention is called to the very simple method shown in Figs. 1 and 2 for finding the centers of gravity of the small trapezoids. The base is divided into three equal parts and lines are drawn from opposite corners through these points. Verticals through the intersection of these cross lines give the proper positions of the centers of gravity and thus the location of the stirrups. In order to make these cross lines less steep, they can also be drawn from the opposite corners of the middle line, as has been done in the diagram.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Kootenay Storage Affects Columbia Development

To the Editor: The papers by Major Butler and Mr. Tiffany, in the September issue of Civil Engineering, quite effectively dispose of the prevalent objections to further irrigation development. I would like, however, to touch on this subject from a different angle. Observation of older agricultural sections of the United States and Canada discloses that large areas of land once profitably farmed are worked out and abandoned. Intensive fertilization as practiced in the older countries is not likely to develop here for another generation or two. The only alternative to allowing our agricultural industry to die is the preparation of new lands to replace the old. In this, irrigation is bound to become more and more a factor of importance.

Development in excess of the rate of demand must be guarded against when reclamation of an area the size of the Columbia Basin is considered. However, at a time like this, the large supply of surplus labor might well be employed on a permanent project for the preparation of these new lands.

Like Major Butler and Mr. Tiffany, I shall avoid making any comment on the relative merits of the gravity and pumping systems that have been proposed for the development of the Columbia Basin Project. It seems advisable, however, to call attention to the fact that the government of British Columbia has granted to the West Kootenay Power and Light Company the right to use for power purposes 6,000 sec-ft. of water from the Pend Oreille River, sometimes referred to as Clark's Fork.

Any dispute which may arise over the use of the waters of this international stream will, under the provisions of the "Boundaries Water Treaty," be referred to the International Joint Commission. According to present practice, priority of right is recognized as the deciding factor, and I am satisfied that the West Kootenay Power Company can claim prior right to the use of the quantity of water stated in its license. Mr. Tiffany states that, even if the Columbia Basin were irrigated from Clark's Fork, there would still be 7,000 sec-ft. available for power purposes on the stream. It is improbable that these power rights would interfere with the diversion of water for irrigation purposes, as the water used for irrigation would be taken from the stream during flood period only.

In addition to the development of the East Kootenay Power Company on the Elk and Bull rivers, which has no effect on the general situation, there is a total completed development on the Canadian headwaters of the Columbia River of 168,000 hp. Also, there are 30,000 hp. under construction and 85,000 hp. held under license, on which construction will probably begin within the next year. These developments are all by the West Kootenay Power Company on the Kootenay River between Kootenay Lake and the Columbia River. The five developments, when completed, will make use of every available foot of head between the Kootenay and Arrow lakes. The plants are all designed for a flow of 10,000 sec-ft., which is available for about nine months of the year.

In order to maintain that rate of flow during the remaining months, the West Kootenay Power Company applied for, and secured, from the British Columbia Government a license to maintain the waters of Kootenay Lake 6 ft. above the extreme low-water line. The average natural rise and fall of Kootenay Lake is about 17 ft. The company proposed, as part of its development program, to clear out the channel of the Kootenay River below Kootenay Lake and so hold down the high-water level.

Under the provisions of Article 4 of the Boundary Waters Treaty, this storage project was referred to the International Joint Commission. So much objection was made by certain agencies on the Idaho side of the line, that the company abandoned the project for the time being at least. It may be of interest to those concerned with the power development of the Columbia River to know that this storage would have exactly the same quantitative effect on the low-water flow of the Columbia River that it has on the Kootenay River. Therefore, it would clearly be of value to any of the proposed developments mentioned in Major Butler's paper and it would possess the great advantage of costing the power interests of the United States nothing. In fact, it is obvious that storage development in Kootenay Lake would be beneficial to any power development on the lower stretches of the Columbia. And the closest cooperation between the United States and British Columbia will result in a mutual engineering advantage.

J. C. MacDonald

Comptroller of Water Rights for the Province of British Columbia

Victoria, B.C.
November 3, 1931

Regulation of the Lower Mississippi

To the Editor: The Mississippi River flood catastrophe in 1927 turned the attention not merely of the entire engineering world, but also of a large number of the people, to the necessity of a final solution for the problem of the control of the Mississippi. It also gave rise to a great number of articles of a polemic nature. This is exactly what happens in Europe after similar, but much less extensive, catastrophies. Although I am personally acquainted neither with the Mississippi and its great flood area nor with the new Army plan for flood control, I have for 50 years been occupied especially with the problems of river regulation.

In all work on streams it must be remembered that the function of rivers is to drain land and that there must be no interference with this natural function. The demands made on a navigable river are somewhat contradictory, as navigation requires a maximum depth at low water, while the interests of agriculture and of the population in the stream area demand extensive protection against floods. Only one solution aids all concerned—equalization of run-off. This can be done by artificial retention of flood water in reservoirs with gradual release of the storage water during low-water periods.

A second method is useful—protection of the river bank from the current and of the levees, where they are in use, against damage by current, waves, and water

pressure. Shore protection not only insures occupation of the adjacent land but also reduces erosion and the amount of sediment that must be carried by the river. This is especially important in the training of the river bed. Determination and protection of the parts of the bank subject to erosion are the first requirements in the regulation of a water course.

Since a river in flood has excessive scouring power, whenever river regulation for navigation is considered, it is essential in developing the river bed to avoid everything that would increase the power of the river. Restriction of the width of a river that during flood breaks through the banks in their natural condition, always results in an increase of its power, a deepening of the pools, and a shoaling of the bars at the crossings. Therefore, where agriculture and habitation necessitate flood levees it is not possible to keep the river from showing very great changes after a flood. These are the unavoidable and natural results of increasing the already excessive power of the stream. Thus rather great changes must be constantly expected in the bed of the lower Mississippi after each flood and, since the regulation of the low-water channel proved to be impracticable, the bars at the crossings must be dredged constantly to maintain navigation at low water.

Aside from its cost and the injury it would cause to navigation in the upper parts of the river, extensive straightening of the river bed cannot be undertaken because of the possibility that it would affect the stability of the location of the navigable channel. But will the planned relief of the river bed by partial diversion of some of the harmful flood water—that is, the difference between the largest amount of water that can be carried by the river without endangering the levees and the maximum flood to be expected—exert a harmful effect on the river bed below the outlet? This can occur only when detritus carried by the water is deposited as a result of a decrease in velocity below the outlet.

It has been proved that the water of the Mississippi is not always charged with sediment to its maximum carrying capacity and that at high water the river holds in suspension but little more sediment per cubic foot than at dead low water, at which time soundings have proved that it makes no deposit in its channel. No practicable high-water outlet or waste weir can occasion any filling of the channel by deposition of sedimentary matter held in suspension by the water.

On the whole, my studies have given me the impression that the best American engineers are working for a solution of the Mississippi problem. May the best solution result from the conflict in opinions!

PROF. DR. ING. HUBERT ENGELS

Dresden, Germany
November 1, 1931

At the Hoover Dam Site

TO THE EDITOR: In connection with Mr. Gerry's article in the July issue—the rocks against which the dam will be in contact include two members of a varied volcanic series provisionally regarded as of early or middle Tertiary age. The older and lower of these two rocks is a sedimentary breccia. This term indicates that the rock is composed of fragments which, in contrast with the rounded pebbles or boulders of a conglomerate, are of angular form. The fragments composing this lower breccia are of all sizes, up to about 1 ft. in diameter. The most abundant of these fragments are of a porphyritic intrusive rock (quartz monzonite porphyry); almost as abundant are the generally smaller fragments of the lava known as andesite.

Because the breccia is composed of fragments or, as the geologists say, is a clastic rock, it has been supposed by some non-geological critics to be necessarily a weak, porous rock and has even been compared, in a disparaging way, with the conglomerate of the St. Francis Dam site. The fact that a rock is composed of fragments, however, does not necessarily denote weakness or permeability. Some clastic rocks, such as quartzites and silicified conglomerates, are among the hardest, most impermeable, and most durable rocks known. It all depends upon the kind and degree of cementation.

To regard the hard and well cemented breccia of the Hoover Dam site as similar to the weak conglomerate of the St. Francis site, feebly held together by clay, is unreasonable. The breccia at the Hoover Dam site is a rock of more than ordinary strength. In its natural position in the canyon walls, supported by the rock around it, it would successfully resist much greater pressures than the 8,000 lb. per sq. in. shown in actual tests. The Colorado River has been flowing over this breccia for thousands of years, and there is no indication whatever of any softening or disintegration of the rock as a result of immersion in water. Although composed of fragments, the breccia is not in any practical sense a permeable rock.

The sedimentary breccia just described is overlain, in the canyon walls, by latite flow-breccia. Latite is a lava intermediate in composition between an andesite and a trachyte. The term, flow-breccia, refers to the fact that it is crowded with small fragments of latite or andesite, which were incorporated when the rock was still in a molten fluid condition. Consequently, the fragments have not been cemented together but are held in a matrix of solidified lava. For all practical purposes, the latite flow-breccia is very compact, homogeneous, and solid. It is harder than the sedimentary breccia and is of unimpeachable character as regards strength, durability, and impermeability.

The contact between the sedimentary breccia and the latite flow-breccia is so close and inconspicuous that it is extremely difficult to find it in the canyon walls. In the vicinity of the dam site, this contact is from 100 to 200 ft. above the river. Consequently, the entire upper part of the dam will abut against the latite flow-breccia, which is the hardest, most massive, and least permeable rock exposed in Black Canyon for some miles above and below the dam site.

Faults are numerous in the general vicinity of the Hoover Dam site, but no important fault or fracture passes through the site. The faults strike generally northwest, or nearly at right angles to the course of the river. None of them shows any evidence of recent movement. Whatever soft crushed material may have originally been present in the fissures has been cemented into rock that is very nearly as hard as the original. The faulting occurred thousands of years ago and has now entirely ceased.

In any consideration of the proposed dam, whether as a gravity structure or as an arch, it must be remembered that it will be solidly keyed into nearly parallel rock walls of unusually strong and massive character. The abutments are not mere mountain spurs but are huge solid rock masses that extend for miles up- and downstream, and away from the river on both sides. The dam as a whole could be dislodged only by a wholly inconceivable wreckage of the exceptionally strong and massive rock walls which will constitute its abutments.

In conclusion it may be stated that, in all geological

respects, the Hoover Dam site displays very nearly ideal conditions. The rocks have been shown by tests to possess strength far in excess of any load which the engineers intend to place upon them. The sedimentary breccia, although not as hard as granite, is probably less permeable than many granites, owing to its relative freedom from joints or cracks. Neither of the rocks at the dam site is deleteriously affected by water, and there is no more danger of leakage through them than there is through the concrete of the dam itself. Even should leakage occur, it could never attain large proportions and could not endanger the dam.

F. L. RANSOME
Consulting Geologist

Pasadena, Calif.
November 2, 1931

Hoover and Other Dams Compared

TO THE EDITOR: The statements made by M. H. Gerry, Jr., M. Am. Soc. C.E., in the July issue, concerning the safety of the Hoover Dam are well taken and true, but they do not disclose all the reasons why the dam design should be changed so as to insure safety for all time.

There seems to be a diversity of opinion on this most important subject of arched gravity dams. That the profession concedes it is a little understood subject is evidenced by the attempt to make a study of the stresses and strains in such dams by the uncompleted experiments carried on at the Stevenson Creek Dam, in California. The tendency is to discard all the factors of safety that gravity gives when materials are placed in positions of natural repose, and to indulge in designs which produce varying internal working strains, wherever possible in directions other than parallel to the force of gravity.

These arched gravity sections are designed with very low factors of safety from overturning by uplift or sliding on the base. They depend on adhesion to the foundation and on arch effect, so that unusual pressures are brought to bear on the abuting walls of the dam site. The greater the span of the arch, the greater the pressure and the deformation of the arch, which is sure in time to cause a separation of the dam from the foundation. This can be hastened by earth waves, which it has been recently demonstrated by Harvard University are constantly at work; by earth tremors of greater intensity; by earth tides; and by earthquakes. These disregarded forces are constantly active, wrecking and leveling. The only structures erected by man which have withstood them through the ages are the Pyramids, built of material in nearly natural repose.

Dams of the dimensions and importance of those under consideration should be designed for perpetuity, and every factor of safety should be taken advantage of. They should have generous slopes upstream and downstream. The slope upstream is the most important as it eliminates uplift and any tendency to slide on the base. On the other hand, a slope downstream, with a nearly vertical upstream face, is favorable to the action of these two principal wrecking elements, making the arch the sole factor for stability. The St. Francis Dam had 100 per cent horizontal thrust on the abutments with all forces parallel to the base, except the weight of the dam, and 100 per cent uplift. If the section had been reversed with the slope upstream, the dam would have had only about 66 per cent of the thrust forces on an angle of approximately 40 deg. below the horizontal falling outside the base, and there would have been practically no uplift. This is a matter where cost should not be considered more important than perpetual safety.

It is claimed by Mr. Gerry that there is more danger to the Hoover Dam from the rock upon which it will rest than from the structure itself. On this point I cannot agree because it cannot be consistently maintained that any works of man can equal in ponderousness the loads the dam-site areas have withstood in their geological history.

For comparative information I have prepared Table I, giving data for a number of important dams of the arched-gravity and straight-gravity types, showing the ratios of width of base to height. It is to be noted that only two out of this list indicate greater safety than the St. Francis Dam, and these are the Hoover Dam and the Hetch-Hetchy Dam, although in the sketch accompanying his article Mr. Gerry tried to show that the upper 200 ft. of the Hoover Dam are weaker than the St. Francis.

TABLE I. RATIO OF BASE WIDTH TO HEIGHT FOR IMPORTANT DAMS

	Length Ft.	Height Ft.	Width Base Ft.	Ratio %
Diablo Dam, Skagit River, Wash.	1,180	389	146	37.5
Bear Creek Dam, Portland, Ore.	950	200	147	73.5
Ariel Dam, Lewis River, Wash.	1,342	200	94	47.0
Gibson Dam, Sun River, Mont.	900	195	87	44.6
Arrowrock Dam, near Boise, Idaho	1,100	349	223	63.9
Elephant Butte Dam, El Paso, Tex.	1,675	306	154	50.3
Pardee Dam, Oakland, Calif.	1,250	345	244	70.7
Hetch-Hetchy Dam, San Francisco (ultimate)	900	312	298	95.2
Owyhee Dam, Ore.	850	405	260	64.2
Hoover Dam, Colorado River	900	740	642	86.7
St. Francis Dam, Los Angeles (failed)	700	209	175	83.7
Mulholland Dam, Los Angeles (altered)	900	200	164	82.0
San Gabriel Dam, Los Angeles (abandoned)	2 400	492	412	83.7
Totoket Dam, New Haven, Conn. (altered)	1,200	108	76	70.6

Of the foregoing, the Elephant Butte Dam is a straight masonry structure and the Totoket Dam is of straight concrete construction. Altogether, these data present a rather risky outlook for the future, except in the case of the Totoket Dam, which has been reinforced on the downstream side by a fill composed of waste material on a 15-deg. slope; and the Mulholland Dam, to which recently a new spillway has been added by tunneling through the dam, to make it safe by lowering the storage level about 30 ft.

It is hoped that there are enough engineers with sufficient vision to realize that they should raise their voices in protest against the present design of the Hoover Dam. What do a few million dollars amount to as compared with the certainty of safety for the large population that will occupy the Colorado and adjacent valleys? This would be wiped out by a flood of such proportions as would be caused by the failure of the Hoover Dam.

WILLIAM HUNTLEY HAMPTON
Civil, Mining, and Consulting Engineer

Portland, Ore.
October 31, 1931

Need for New Set of Traffic Terms

TO THE EDITOR: The list of suggested definitions in the report of the Committee on Street Thoroughfares in the September issue of CIVIL ENGINEERING brings to mind certain points in connection with nomenclature and usages in the designation of streets. On the subject of highways the engineer and the layman can meet on more nearly common ground, so far as language is concerned, than is possible in any other engineering field. I refer particularly to the marking of highway warning

signs. However, practice in this respect is by no means uniform throughout the country, or even within single states. Streets in which traffic is so heavy that intersecting street traffic is required to come to a dead stop before entering or crossing them are variously designated by such warning signs as "boulevard stop," "arterial stop," or merely "stop."

These and similar loose usages generally tend to destroy the distinctive meanings of the terms so applied. Whether such indefinite terminology is the fault of engineers, of the public at large, or of both, it creates a situation engineers might well object to. If the engineering profession, by adopting a generally accepted set of definitions such as the Committee on Street Thoroughfares suggests, can create uniformity in highway terms and their accepted meanings, it will benefit both itself and the motoring public.

"Boulevard," "express street," and "arterial street" are terms frequently used with overlapping meanings, and a similar condition is found in the case of certain other terms. It may therefore be that no improvement of the present confusing situation can be made by limiting too narrowly the meaning of each term, contrary to present general practice. However, if the influence of organized effort can bring about the general acceptance of a clear-cut set of definitions, a very real service will have been rendered.

Philip H. Ward, Jun. Am. Soc. C.E.

Westfield, N.J.
November 5, 1931

Highway Expenditures Must Be Economically Justifiable

To the Editor: I have not seen in any of the Society's publications any mention of the taxpayer's part in highway planning and expenditure, whether for first cost or maintenance. The engineer has apparently considered it his first duty to solve traffic problems and his second to devise various schemes for raising the money called for by his plans—even to the extent of confiscating property for street widening. The present world depression ought to serve as a reminder that there is another aspect to these problems.

How long can the humble taxpayer continue to meet the constantly increasing demands made by mounting government expenditures, of which highways represent too large a proportion? The politician turns from one source of tax revenue to another—from gasoline tax to income tax—but in the end the public pays. This situation cannot last and is apt to bring a slowing down of, if not a complete halt to, further progress. To avoid possible serious consequences it would seem as if much extended and involved research were needed.

The discomfort of trying to drive in Westchester County, New York, where there is a great deal of traffic on the main highways—especially those paved with concrete and two or more lanes in width—has led me to try neglected back roads. The result has been the discovery of scenery far more pleasing than that afforded by refreshment stands, billboards, and the other man-made blemishes found on the main arteries.

These observations were reinforced by a motoring trip on British roads. It is obvious that the British taxpayer could not and would not pay for our wide roadways. English roads are narrow, though excellently paved. Should we not voluntarily accept narrower roads instead of having to stop highway improvement? Our present program of road widening imposes an unjust as well as an uneconomic burden on taxpayers.

The gasoline tax is not, by any means, the answer. The present dilemma of our railroads is due to two particular conditions. On the one hand, the railroads are subject to excessive taxation; and on the other, their competitors are furnished, at public expense and without adequate return to the state, the equivalent of railroad roadbeds and rails. What would happen if those who could afford to buy anything from a handcar to a locomotive were allowed free use of the rails between New York and Albany (or any other two points)? Yet this is exactly what is being done on modern highways—especially those three and four lanes wide, which cost as much or more than many tracks of railroad lines in the United States.

Would it not be better to increase the mileage of usable roads for the property owner instead of trying to take care of all possible traffic between two centers of population? Certainly the farmer would benefit from a 12-ft. highway past his farm far more than he would from a concrete speedway from 20 to 60 ft. wide for hauling produce from a point 100 miles or more away from his farm to a trading center. The 12 or, at most, 16-ft. roadway could be made comfortably usable in all kinds of weather without such expenditure for construction as is now lavished on the main highways—that is, for every $100,000 spent on construction or maintenance more mileage could be improved and kept in repair.

More of the injustice suffered by taxpayers could be removed if these main improved roads were made toll roads, the revenues being used to amortize their cost. If objection is made to this on the ground that cars could save tolls by using the narrow roads, shortly pounding them to pieces, it only proves my contention that, up to the present time, plans have not taken into consideration all the facts. Much traffic, if assured of comfortable going under pleasanter conditions, would willingly spend the little extra time consumed by following a side road.

The assumed advantages of express highways need reexamination from the standpoint of the greatest good to the greatest number of people at the least cost to all. In short, if public utilities treated any of their consuming public as engineers and taxing authorities treat the humble taxpayer, the charge of discrimination would be raised at once and a rate case would follow.

Francis W. Collins, Assoc. M. Am. Soc. C.E.

New York, N.Y.
November 8, 1931

Highway Parasites Should Be Eliminated

To the Editor: In the article on "Increasing Highway Efficiency," in the September issue of Civil Engineering, Mr. Hewes brings out the fact that highway parasites present the outstanding problem in highway operation. Unfortunately these parasites do not encumber the unimproved roads, but instead are placed where the greatest expenditures have been made to meet transportation needs.

If billboards and hot dog stands are to be abolished the impetus will have to come from the state exercising its police power or from an enlightened and aroused public opinion that renders operation of these menaces unprofitable. It is my belief that much more can be done through the police power of the state than has so far been accomplished. This power has been successfully invoked to protect the health, peace, safety, and property rights

of the public. In fact, police power functions continuously in other respects for the welfare of the people.

It must be realized that a great many, if not all, billboards invade the rights of the public. In face of the fact that automobile accidents are responsible for over 30,000 deaths a year, it should not be difficult to convince the courts that billboards near curves or intersections are a menace to safety. They are erected to be looked at, but no one can safely look at a billboard and, at the same time, drive an automobile around a curve or through an intersection, or anywhere else. Billboards and traffic hazards both increase in number and magnitude as large cities are approached whereas, in the interests of traffic safety, they should decrease in number and size near cities. If billboards were erected only where they would not constitute an actual or potential traffic hazard, so few people would look at them that their maintenance would be unprofitable.

Traffic engineers should prove that large and improperly placed billboards endanger the safety of the traveling public, and thus establish the validity of regulatory laws limiting the size, number, and location of such signboards.

The validity of placing billboards should also be attacked on other grounds. Outdoor advertisers should be licensed for the same reasons that plumbers, barbers, and civil engineers are licensed. Their billboards should not provide protection for undesirable characters and should be so designed as to be proof against demolition by high winds. Periodic inspections would be necessary to secure such results, and this would require a license fee for each billboard placed. The advertiser should be obliged, under penalty of a fine, to secure the consent of property owners before erecting any billboard. Such requirements would necessitate the payment of a rather high license fee on the part of the advertiser, and would result in a decrease in the number of billboards.

These menaces may also be attacked on esthetic grounds. A hideous glaring sign or an unpicturesque eating shack constitutes as great a nuisance to many people as does a glue factory. The courts under many circumstances will recognize an evil smell as a nuisance and will not tolerate the noise of a boiler factory in a residential community. Just why it is legally impossible to offend the sense of sight alone is something of a mystery. The American prople are too tolerant of such offenses, and progress along this line must await the slow crystallization of public sentiment.

There should be a continuous campaign against the illegal, or extra-legal, sign. It is almost universally illegal for private signs to be placed within the limits of the right-of-way, but signs so placed are constantly appearing. If highway maintenance departments would make the removal of such signs one of the regular duties of patrolmen or maintenance crews, and if the agencies whose advertisements appear on such signs were prosecuted and fined, there would be a great improvement in the appearance of our roadsides.

Much of what has been said about billboards applies to hot dog stands. If they are close to the right-of-way line they encourage parking on the highway, with its attendant danger to traffic. In the interests of safety the proprietors of these establishments can, and should, be compelled to provide parking space on private property for their patrons. They should pay a license fee and be compelled to conform to city standards of cleanliness in matters of water supply, sanitary facilities, and sewage disposal, and especially in matters of handling, preparing, and serving food and drink. If all eating places outside of city limits were compelled to meet the standards enforced in many cities, the number of such establishments would automatically decrease. State laws should be amended to give county commissioners and health boards larger powers of inspection, and the expense of such inspection should be met by fees paid by the eating places.

H. E. PHELPS, M. Am. Soc. C.E.
Professor, Highway Engineering
State College of Washington

Pullman, Wash.
November 5, 1931

St. Johns Bridge Sets New Goals

TO THE EDITOR: After reading Mr. Steinman's article on "Rope Strands for Long Suspension Span," in the September issue of CIVIL ENGINEERING, one is inspired by the fact that this was primarily a job in which many things were done for the first time. The large suspension bridge and its approaches were built without the use of a concrete mixer except for paving the roads and pouring the two main piers, which was done by the great marine mixing plant. The balance of the concrete was brought on the job assembled, complete, and ready for application. All of it was guaranteed as to strength and then tested to prove the guarantee. We have learned not to haul the voids in our concrete aggregates, and to deliver assembled manufactured concrete.

The two main towers which rise 400 ft. above the water were built from adjacent towers of wooden falsework instead of by the usual creeper traveler erection. This new use of wooden structures was admitted by all who saw them after they were up and in place to be the obvious method. The advantage of working from these towers is indicated by the fact that, during the first four hours of erection, two 35-ton pieces and five 25-ton key pieces were set in place accurately and without the least delay. The method of suspending the stiffening trusses from the cable was new and seemed, at first approach, one of the things that could not be done. However, after it had been accomplished, it seemed so obviously simple that we all wondered why it had not been done before. The method of handling the cable across the river without cat walks was novel. Along with this came the development of the stranded cable fabricated into a larger cable and longer span for a higher bridge than had ever before been erected. As a result of this new use of stranded cables, the Roeblings, long associated with suspension bridge construction, worked out other novel construction features.

With development, the contracting business has become an increasingly complex undertaking. Work on the St. Johns Bridge was rated in such a manner as to encourage the existence of competitive conditions in the bidding. When the competition was over, the various successful contractors had no feeling that there was any particular lack of dignity in being "subs." Each one was given an opportunity to work on that part of the job which his specialized equipment particularly fitted him to undertake.

Construction of the St. Johns Bridge has thus introduced into engineering practice a number of innovations. This work has indicated the great economic change which has taken place in West Coast manufacturing through the increasing trend toward shipment of raw materials from the East for fabrication on the Coast.

The St. Johns Bridge represents a splendid piece of work. Nuts and turn-buckles have been carefully turned and every slight air bubble in the concrete finished out. It is a workmanlike job done by contractors of

courage, ingenuity, initiative, and skill. Except for two Eastern firms on the job, the work was done by Westerners who built, for the first time west of Detroit and 2,000 miles from its prototype, a suspension bridge of masterly design and dimensions. This structure, which is satisfactory in every respect to those who avail themselves of its facilities, was built within the estimate, the specifications, and the time limit set for it.

George B. Herington
Consulting Engineer

Portland, Ore.
October 31, 1931

Use of High-Stress Concrete in Viaduct Construction

To the Editor: I was greatly interested in Dr. Steinman's article on the St. Johns Bridge, in the September issue of Civil Engineering. If the conventional system of allowing safe working stresses had been used on the construction of the east approach of this bridge, a considerable saving in the cost of the concrete would have been effected. In fact, construction along the lines of viaduct or concrete design on the basis of 1,000 to 1,200 lb. per sq. in. for the concrete and of 16,000 lb. per sq. in. for the steel would have enabled a saving of approximately $130,000.

At the same time, however, much of the esthetic effect of the structure would have been lost. The effect of the Gothic arches, especially when seen from the first undercrossing near the abutment, reminds one of the churches and cathedrals in old European cities. The low piers and columns in the bridge have almost the same proportions as those in the 136-ft. pier. Unquestionably, this esthetic effect is far more important than any slight saving in the total cost (approximately $4,000,000) of the bridge. This is especially true since funds for the project were obtained through the sale of bonds, and property owners were not assessed.

When the design of the approaches to the bridge was finally adopted, there was considerable discussion on the subject of grade separation. It was felt that it should be possible for traffic on the north and south approaches to proceed in either direction without crossing lanes of traffic on the western entrance to the bridge. Of course, this is a detail that can be worked out later. When the need arises, it will be entirely possible to separate traffic on the west side.

The Mill Street crossing on the western approach to this bridge represents a departure from the usual method of viaduct construction in Portland. It was designed and constructed using a 90-ft. plate girder span encased in 6 in. of concrete, which necessarily increased the cost of construction.

In the building of viaducts and arch bridges, the engineering department of Portland at other locations has increased the cement content to a mixture of approximately 1:1:2, decreased the water and cement ratio, and used the higher working stresses in the concrete—1,000 to 1,200 lb. per sq. in. This combined with either ready-mixed or transit-mixed concrete—preferably the transit-mixed—gives a uniform mixture which will produce better results than the lower grade. Several bridges of this type have been built in Portland up to a span length of 88 ft. for the girder type and 250 ft. for arches.

The dead load is decreased which means that smaller members and consequent longer spans are possible. Use of this type of concrete also facilitates the construction of thinner slabs, which are of considerable importance in obtaining overhead clearance for railroads and traffic. Smaller and thinner members are more flexible in adaptation to temperature and other changes. This type of concrete is more workable, more easily placed, more permanent, and more uniform in texture than the standard product. No admixture is necessary for it. Also, it is less subject to deterioration from the weather and is more receptive to subsequent treatment, such as sand blasting or stone hammer dressing.

The synchronic action of concrete and steel in a reinforced member is promoted by a greater modulus of elasticity in concrete and a greater bond value between steel and concrete. So if that type of high-stress concrete had been used in construction of the Mill Street viaduct at the west approach to the bridge, it is possible that a saving of about 40 per cent in first cost might have been effected.

Olaf Laurgaard, M. Am. Soc. C.E.
City Engineer

Portland, Ore.
November 1, 1931

Public Utilities in Tacoma

To the Editor: I was interested in the article, "Some City Planning Problems of Tacoma," which was published in the September issue of Civil Engineering, but I should like to supplement the information which Mr. Putnam has presented—particularly on the subjects of water, light and power, and port development.

The present gravity supply from the Green River has a capacity of 46 m.g.d., which is conveyed through a single conduit 43 miles long. Over 40 miles of this line were originally built of continuous wood stave pipe construction. Reconstruction of parts of the wooden portion of this line was begun in 1924, eleven years after its original installation. From $1^1/_2$ to 3 miles are being rebuilt each year, and it is planned to complete the reconstruction of the entire line by 1940.

In order to protect the city water supply from hazards during the reconstruction period and to furnish large industries, such as pulp and paper mills, low-cost water of high quality, an underground supply is now being developed. Under this program it is intended to develop a capacity of not less than 45 m.g.d. before the end of 1932. Five wells have already been completed, and preliminary tests show a yield of over 25 m.g.d. One well of phenomenal capacity is expected to average from 9 to 10 m.g.d. This water can be sold as low as $20 for a million gallons at a profit to the city.

In general, supply and demand as well as income and financial obligations have been set up and analyzed for a period of over 20 years in the future, so as to enable the city to offer to large industries long-term contracts on a low-rate basis.

Tacoma's present power supply consists of a municipal system provided with three hydro-electric plants aggregating 157,000 hp. and two steam plants totaling 45,000 hp. Some of the industries in the city are supplied from the system maintained by the Puget Sound Power and Light Company. That the city is preparing for the future is evidenced by the fact that plans have been made for hydro-electric plants aggregating 173,000 hp. to be developed as needed in the next few years. Also there will be steam plant additions totaling 100,000 hp. to be made in units of 33,000 hp. as needed.

In the development of the Tacoma Harbor the prob-

lem is not so much one of providing additional dockage facilities for the purpose of handling freight from ship to rail or vice-versa, as it is a matter of creating large areas at low cost for industrial plants. Ample dockage facilities are now available, but large industrial sites with water-front and rail accommodations are at a premium.

Under existing conditions, the plan adopted appears to provide an economical and logical solution to this problem. The layout provides for a main channel on the north side of the Tide Flats with secondary waterways branching therefrom and extending in a southern direction into the area to be filled by dredging. This would make an ideal arrangement for the accommodation of rail and street traffic with the least number of bridges. If necessary, it could be carried out in small units, would cause practically no interference with existing improvements, and would simplify construction for the light, power, and water utilities of the city.

The establishment of the freight segregation and assembly yard, as well as the possible construction of a secondary airport, has been taken into consideration in planning this tentative layout.

W. A. KUNIGK, M. Am. Soc. C.E.
Superintendent, Water Division
Department of Public Utilities

Tacoma, Wash.
October 31, 1931

Latin-American Syndicate an Illogical Proposal

DEAR SIR: I wish to comment on the letter by Dr. Waddell, in the November issue, and to record my total disagreement with his suggestions. His statement that Latin America has vast potential resources and business possibilities but little money for desired improvements is correct. The method proposed for remedying this condition would be entirely ineffective so far as the engineering and construction business is concerned.

For fifty years, meritorious construction enterprises in South America have been under closest scrutiny. Through a process of intelligent selection and hard work, the best of them have been brought to a state of high development and, in many cases, of great prosperity. Some of the important South American developments in the past 30 or 40 years have been Brazil Traction, American and Foreign Power, All American Cables, and I. T. & T., besides copper, manganese, and nitrate developments. In justice to our European competitors, it must also be said that, in the past 30 years, some of their great work has been done in South America.

An examination into the history of all these enterprises, in which billions of dollars have been invested, points out how the commercial feasibility and economic justification of projects of this kind are demonstrated and their financing thereby made possible. This is through long familiarity with the conditions surrounding the industry and the country in which it is to be built, shrewd appraisal of the growth and future profits which may be expected, and highly trained commercial sense, seasoned in the commerce of the country. None of these bases for judgment can be conjured through the waving of a wand out of the supposed superior ability, knowledge, resources, and initiative of Americans. For half a century competent American construction organizations have competed for business in South America and have won some of it against favored English, French, Dutch, and German competitors who had advantages in financial support.

Dr. Waddell's suggestion of using lecturers appears to me to be an aspersion on the character of these enterprising construction organizations which have heretofore obtained business in South America. Must we assume that propaganda is necessary to demonstrate that we have now turned over a new leaf? Or should not the syndicate rather admit from the start that its members, having found competition difficult, are now urged through a hope of profit to extend operations into new fields?

No—although it must be admitted that the South American countries need money and that they have obtained and spent money unwisely in mere beautification of their cities, or in the carrying through of enterprises which will only have been proved sound 50 years from now, such "errors" must be attributed to human nature which, unfortunately, is never entirely sound in its judgment until after the event.

South America is now going through a period of over-optimism, over-development, over-indebtedness, just as our own country did in the period from 1830 to 1890, and the results are strikingly similar. We can hardly assume that anyone in this country will be an acceptable mentor to the South American countries in their present state. In justice to human nature, South Americans—even those who are in the depths of a financial morass—can hardly be expected to admit the kind of inferiority which is implied in this sort of proposal.

There are three requirements for developing enterprises of a meritorious character in Latin-American countries:

1. An intimate knowledge of the country, developed through long years of residence and close contact with the best business elements there
2. Association with strong banking houses in the United States
3. Hard work, sound technical knowledge, and judgment applied to stripping any project of its unsound and unsafe features and developing from the kernel a strong, vigorous, attractive business enterprise. This involves the kind of skilled technical and construction organization which Americans have contributed in the past to South America and which is valued by South Americans when applied to their problems by qualified and experienced personnel.

GEORGE SCHOBINGER, M. Am. Soc. C.E.

Philadelphia, Pa.
November 6, 1931

To Stabilize Latin-American Finances

DEAR SIR: Dr. Waddell's suggested Latin-American Engineering-Contracting-Financing Syndicate, briefly described in his letter in the November issue, may be sound in theory, but in my opinion its formation is unjustifiable at present and probably so in the fairly distant future.

There are outstanding at present about 60 external loans listed on the New York Stock Exchange and 5 loans listed on the New York Curb Exchange representing, at par, an enormous debt owed by Latin America. The principal and interest as paid do not remain there; all such payments go to outsiders. These represent only the external loans of the countries, states, and in some instances cities of Latin America, and do not include any of their internal debts. At present prices, the value of the bonds issued on account of these external debts varies from a minimum of $8 to a maximum of about $50 on a par value of $100. In all cases the interest rates are high. Bonds of even the small towns in the United States stand at par or better in spite of the depressed market of today.

It would appear that, instead of experiencing difficulty in obtaining funds from outside, Latin America has had its potential possibilities over-exploited by ambitious bankers, business men, and engineers, principally of the United States, France, and England. Undoubtedly it needs a chance to digest the funds already borrowed and to build up earnings to support them before undertaking any more such projects.

Few, if any, of the countries of Latin America have governments of sufficient political stability to guarantee the safety of American investors' dollars. Already there are in existence American engineering-banking-construction organizations, whose representatives have no doubt made a thorough reconnaissance of the commercial possibilities of Latin America and who are ready without further ado to take advantage of and exploit any situation with even remote possibilities.

Until Latin-American countries can establish more permanent governments, and digest the loans already obtained from outside investors, there would seem to be little if any reason for launching another syndicate of engineers, constructors, and bankers. As one interested in foreign affairs and in the general welfare of Latin America, I do not believe it sound business to attempt to extricate ourselves from a business depression, nor for our engineers to try to make work for themselves, by further exploitation of the latent wealth of our Latin-American neighbors, a number of whom are at present finding it difficult to pay the interest and sinking fund on money so willingly loaned them by American and other outside bankers a few years ago.

If American engineers, contractors, and business men are serious in a desire to help develop Latin-American countries and, incidentally, to profit therefrom, they should go there in large numbers, settle permanently, and help by taking a leading part in establishing stable governments. They should set about developing the resources of the continent as residents and equity holders—thereby putting back into the land at least a part of the created wealth and profits—rather than by placing additional heavy mortgages on the resources of the land through external loans, which result largely in draining wealth from the country.

Wilson T. Ballard, M. Am. Soc. C.E.
Vice-President, The J. E. Greiner Company

Baltimore, Md.
November 3, 1931

Recalling the Pan-American Chamber of Commerce

To the Editor: On reading Dr. Waddell's letter in the November number, entitled "A Latin-American Engineering and Construction Enterprise," I was reminded of a similar effort undertaken about 21 years ago.

The late Julio F. Sorzano, M. Am. Soc. C.E., labored for many years over a Pan-American Chamber of Commerce. The chamber was founded about 1910, and maintained an office on lower Broadway, New York. Here the members could see papers published in the West Indies, Central and South America, and also reports sent by the chamber's representatives in the various countries, relating to all projected public and private works. The chamber was equipped to make translations and seek special information as desired. Its membership was to be composed of firms and individuals engaged in financial, engineering, and construction work. The object was to advertise American-manufactured articles in the Latin-American countries and to aid in obtaining engineering and construction contracts of all kinds from those countries for its membership.

The enterprise did not succeed because unanimity of confidence could not be maintained by its members. Rival corporations and firms wanted to secure the work, each for itself. The foreign members lost faith in the chamber, and the American members lost faith in one another.

H. de B. Parsons, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
November 7, 1931

Merit in Proposed Latin-American Engineering Corporation

Dear Sir: In connection with Dr. Waddell's letter in the November number it may be interesting to recall that in 1915 the American International Corporation was formed with a capital of $50,000,000 for the very purposes now suggested. The board of directors of this corporation included the names of men of great prominence in banking and industry in the United States. At that time, just after the beginning of the European War, all the countries of the world not immediately involved turned to the United States for the financing of public works. These projects were such that they generally involved engineering and construction as well as finance, and consequently did not appeal to purely banking interests.

The American International Corporation was therefore formed, and combined in its staff elements of finance, engineering, and construction. In theory it was expected that its capital of $50,000,000 would be used to take up issues of bonds which were authorized or guaranteed by various foreign governments or governmental entities, which were not at that time marketable. It was expected that with these issues of securities, there would be coupled contracts for the actual carrying out of works of public utility; that when the original capital was used up, debentures could be issued, backed up by the (then) unmarketable but good securities; and that, in course of time, these securities might become saleable. History since that time has shown that this would have been the case.

Unfortunately, as I think, practically nothing of this kind was done, and the capital of the enterprise was used for other purposes, mostly commercial and domestic. I think that this was due very largely to lack of knowledge of conditions in foreign countries outside of Europe, and to a really unwarranted fear of instability in the countries of Latin America.

Experience has shown that well selected securities of Latin-American governments have been, on the whole, almost as stable as many issued by those governments which we have been accustomed to speak of as the Great Powers.

The general idea expressed by Dr. Waddell is eminently sound and could be worked out if the proper elements were brought together. I do not think, however, that his idea of entrusting the management of such a syndicate or corporation to a large body of engineers and contractors would work out. These enterprises involve primarily finance on a large scale. But I think that if the set-up were properly made there is a place for an organization in which finance could be combined with engineering and construction. The enterprise would necessarily have to be set up in corporate form. The head of it would have to be a man of ability, sympathetic to, and having knowledge of, Latin-American conditions and of the financial situation in both the United States and Europe.

I doubt also if the lecturers referred to by Dr. Waddell would have any particular place in a proposal of this kind. It is fairly well known what projects the governments of most of the countries of Central and South America desire to have carried out, and such an organization would best develop its business by obtaining one or two contracts and then carrying on its business from that point, just as any other commercial or industrial organization might be started from a small beginning.

It should be borne in mind, also, that even though this organization were of the highest and most altruistic type, it would have to be conducted on a business basis and its services would have to be sold; also that the cost of salesmanship might run into fairly high figures before a remunerative and practical contract were negotiated. Real salesmanship, backed up by a sympathetic attitude and ability in the home office, and then honesty and ability in carrying out the work, are the only means by which an enterprise of this nature could be made to succeed.

F. LAVIS, M. AM. SOC. C.E.
Consulting Engineer

New York, N.Y.
November 2, 1931

Hydraulic Dredging for Mississippi Improvements

TO THE EDITOR: Mr. Kemper's interesting paper on the "Better Control of the Lower Mississippi," in the August issue, proposes a separate floodway and navigation channel down the Boeuf and Tensas basins at a cost of $150,000,000 and requires the moving of about one billion cubic yards of earth. Hydraulic dredging would be the most suitable and economic method for handling this large quantity of earth which, if the materials were favorable, could be done for considerably less than Mr. Kemper's estimate. But what would be the stability of this floodway? Is bank protection intended to prevent erosion during flood conditions? The floodway would require markers indicating the deeper central section so that shipping would not ground on the flat side slopes. This proposed channel sidesteps a number of important cities on the main river, and tonnage to these points would have to be handled as before, with only through tonnage handled in the floodway. Would a separate navigable channel be warranted for that purpose?

Many plans have been advocated for controlling the Mississippi River. One by Gardner S. Williams, M. Am. Soc. C.E., requires taking out the bends as well as widening and deepening the river from Cairo to the Gulf. This plan calls for a minimum removal of about 18 billion cubic yards of earth. A good-sized job! However, it is one that could be handled with hydraulic dredges, many of which have a capacity well over a million cubic yards per month. For a job of this size additional dredges would no doubt be built with greatly increased capacity. Possibly a further study of this plan would indicate that more of the present river channel could be used than was originally contemplated, thereby reducing the amount of dredging required. All cut-offs and straightening operations would of course first be subject to study and experiment in hydraulic laboratories showing the river's behavior and treatment required. Straightening the river would shorten it, and therefore proportionately better bank protection could be provided at the same cost as before. The increase in current velocity would augment the silt and water-carrying capacity of the channel; whether it would also increase troublesome erosion of the straightened river channel banks over and above what is now occurring is doubtful. Experience seems to indicate a gradual deepening and widening of other river channels so treated. The excavated material would be used for widening and raising the levees and the ground level adjacent to the levees as much as possible. A good highway built on top of the completed levees would be of great value for patrolling and for quick access in an emergency as well as for pleasure touring.

If the $150,000,000 proposed by Mr. Kemper for a separate floodway were used on the river, as suggested in the foregoing plan, it would go a long way toward making the river safe against any ordinary floods for the proposed floodway distance. Also, the improvements from straightening the river would be evident as work progressed to a greater extent than on the floodway. Navigation would be greatly improved by the straightening and shortening of the river.

The old theory advanced by Humphreyes and Abbott and to a certain extent confirmed by experience—that when a bend in the river is removed by a natural cut-off trouble is experienced from erosion—now appears to be disproved by the new hydraulic laboratory at Vicksburg which indicates somewhat improved conditions from cut-offs in the experiments so far conducted. Can it be that through all these years millions of dollars have been used for protection of the bends in the river, when it would have been better to have had them removed?

Mr. Kemper's paper paints a pessimistic picture of what will happen in the Boeuf, Tansas, and Atchafalaya basins every four or five years with the now proposed fuse plug levee system. If these fears are confirmed by further investigation, it would seem well to consider some other plan that would eliminate the damages and hardships attendant to flooding so much country. It seems that a plan confining the river to a straightened and navigable channel for all time would be the most acceptable to the people in the valley and to the Nation, even though the cost be greatly in excess of the plans now contemplated.

OLE P. ERICKSON, M. AM. SOC. C.E.
Great Lakes Dredge and Dock Company

Chicago, Ill.
October 14, 1931

Columbia and Colorado Rivers Compared

TO THE EDITOR: I should like to bring up a point suggested by Mr. Tiffany's article in the September issue of CIVIL ENGINEERING, in which he makes a comparison between the Colorado and the Columbia rivers. In this connection, he left unmentioned a factor of the greatest importance, which is that the Colorado River carries a great deal of silt. This means that, so far as is now known, every reservoir built on that river will gradually deteriorate in capacity. This is true of the Rio Grande, which silts up at the rate of 20,000 acre-ft. per year. I believe that the average annual silting at Hoover Dam will be 75,000 acre-ft.

There will be some sand and a small amount of silt carried into the Columbia River Reservoir, but that amount of deterioration will be nothing in comparison with the amount that must be expected on the Colorado River. This is a point of extreme importance in favor of the Columbia River.

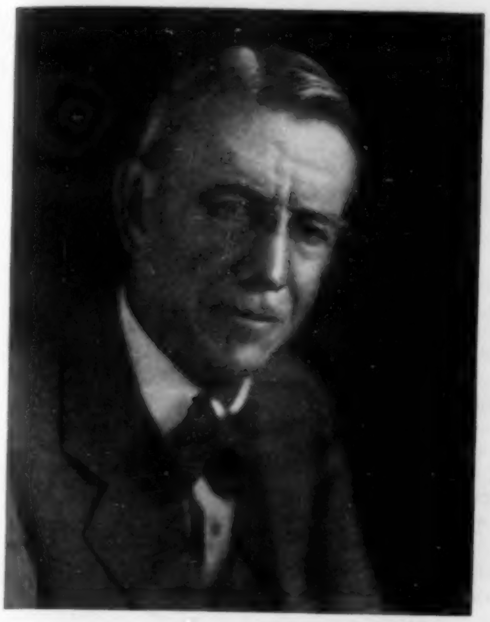
D. C. HENNY, M. AM. SOC. C.E.
Consulting Engineer

Portland, Ore.
October 26, 1931

SOCIETY AFFAIRS

Official and Semi-Official

Honorary Members 1931



Daniel Webster Mead
Consulting Engineer
University of Wisconsin

George Watson Kittredge
Consulting Engineer
New York Central Railroad

Palmer Chamberlaine Ricketts
President, Rensselaer Polytechnic Institute, Troy, N.Y.

George Herndon Pegram
Chief Engineer, Interborough Rapid Transit Company, New York

Honorary Members Selected

The highest honor within the power of the Society to bestow is that of Honorary Membership, which comes to those who stand high in the profession, as a fitting climax to active and especially significant careers. Frequently a Past-President receives the coveted award, but the recipient may not have formerly held membership in the Society. In 1921, both Ferdinand Foch, Marshall of France, and Luigi Luiggi, Senator of Italy, were elected; Baron Koi Furuichi, Privy Councilor of Japan, was elected in 1929.

Of the 16 Honorary Members listed in the 1931 Year Book there are 6 Past-Presidents of the Society; 3 who had held no previous membership; 11 who have held membership in some grade for over 30 years; and 5 whose membership in the Society dates back almost 50 years. A brief record of the careers of those who were elected by the Board of Direction at its St. Paul Meeting in October 1931, follows:

GEORGE WATSON KITTREDGE

Born in North Andover, Mass., on December 11, 1856, George Watson Kittredge was educated in the public schools of North Andover, and was graduated from the Massachusetts Institute of Technology in 1877, with the degree of B.S. in Civil Engineering. Mr. Kittredge began the private practice of engineering in eastern Massachusetts in 1877 and 1878, and was with the South Boston Flats Improvement in 1878 and 1879. He was with the engineer corps of the Pittsburgh, Cincinnati, and St. Louis Railroad Company from 1880 to 1883; and held the position of Division Engineer on Maintenance of Way for different divisions of the Pennsylvania Lines West from 1883 through 1890.

In 1890 and 1891 he was Assistant Chief Engineer of the Cleveland, Cincinnati, Chicago, and St. Louis Railroad Company, and from 1891 to 1906 was its Chief Engineer. His service with the New York Central as Chief Engineer extended from 1906 to his retirement in 1927. During this time he was also Chief Engineer of the Hudson River Connecting Railway and other subsidiary lines of the New York Central, and was Valuation Engineer of the New York Central and Consulting Valuation Engineer of the New York Central Lines. Since 1927, Mr. Kittredge has maintained an office as consulting engineer in New York City or Yonkers, and has acted as consulting engineer, not only for the New York Central, but for other lines in the United States and Canada.

From 1911 to 1927, Mr. Kittredge was Vice-President of the Eastern Railroad Association, and a member of its executive committee. He is a former president of the American Railway Engineering Association. He served the Society as Director from 1908 to 1910, and as Vice-President during 1917 and 1918. He has also been active in committee work and on the Library Board of the United Engineering Society.

DANIEL WEBSTER MEAD

Daniel Webster Mead was born in Fulton, N.Y., on March 6, 1862. He was graduated from Cornell University in 1884, with the degree of C.E. He was with the U.S. Geological Survey in 1884 and 1885; served as City Engineer of Rockford, Ill., from 1885 to 1887; and was Chief Engineer and General Manager of the Rockford Construction Company, from 1888 to 1896. Since 1896 he has acted as consulting engineer on hydraulic works and power plants and since 1904 has been Professor of Hydraulic and Sanitary Engineering at the University of Wisconsin.

He has built water works for Rockford, Ill., Fort Worth, Tex., and other Western cities; filters for Moline, Danville, and Quincy, Ill.; hydro-electric plants at Kilbourn, Wis., at Prairie du Sac, Wis., and at many other places.

He is a member of the firms of Mead and Seastone, of Madison, Wis., and of Mead and Scheidenhelm, of New York City. He was a member of the Red Cross Commission to China, on flood protection of the Huai River, in 1914; and Consulting Engineer of the Miami Conservancy District from 1913 to 1920. In 1928 President Coolidge appointed him to the Colorado River Board to pass on the plans for the Boulder Canyon Project. He is a member of the American Society of Mechanical Engineers, the American Water Works Association, the New England Water Works Association, the American Institute of Consulting Engineers, the Wisconsin Engineering Society, and the American Association for the Advancement of Science, and holds the grade of Fellow in the American Institute of Electrical Engineers.

Among his published works are: *Notes on Hydrology*, 1904; *Water Power Engineering*, 1908; *Contracts, Specifications, and Engineering Relations*, 1916; *Hydrology*, 1919; and numerous papers read before scientific societies or published in the bulletins of the University of Wisconsin. He has served the Society on a number of committees, notably those concerned with engineering education and Mississippi River flood control.

GEORGE HERNDON PEGRAM

Born in Council Bluffs, Iowa, on December 29, 1855, George Herndon Pegram was graduated with the degree of C.E. from Washington University in 1877. The same university also gave him the degree of M.A. in 1905, and that of LL.D. in 1928. He was Engineer on Construction of the Utah and Northern Railway of Idaho in 1877 and 1878; principal assistant to C. Shaler Smith, Bridge Engineer, from 1878 to 1880; and Chief Engineer of the Edge Moor Iron Company of Wilmington, Del., from 1880 to 1886.

He maintained an office as consulting engineer in New York City from 1886 to 1889; acted as consulting engineer of the Missouri Pacific Railroad from 1889 to 1893; and was Chief Engineer of the Union Pacific Railroad System from 1893 to 1898. He was also consulting engineer for the Pioneer Electric Power Company during the construction of its plants at Ogden and Salt Lake City, Utah. From 1898 to 1905 Mr. Pegram was Chief Engineer of the Manhattan Elevated Railroad and since 1905 has been Chief Engineer of the Interborough Rapid Transit Company, and of the Rapid Transit Subway Construction Company. From 1912 to 1914 he was Chief Engineer of the New York Railways Company.

He designed the Kansas City Elevated Railroad, and the St. Louis Union Station; invented and patented the Pegram truss for bridges in 1889; and designed and built a combined highway and railway bridge across the Arkansas River at Fort Smith, Ark., in 1890. He served the Society as Director from 1902 to 1904, as Vice-President during 1909 and 1910, and as President in 1917. He has been active on a number of committees, and as a trustee of the United Engineering Society.

PALMER CHAMBERLAINE RICKETTS

On January 17, 1856, Palmer Chamberlaine Ricketts was born at Elkton, Md. He received the degree of C.E. at Rensselaer Polytechnic Institute in 1875, and began his work there as instructor in the same year. During his contact with Renssalaer he was Bridge Engineer for the Rome, Watertown and Ogdensburg Railroad, from 1887 to 1891; engineer of the Public Improvement Commission of Troy, from 1891 to 1893, when many miles of sewers and roads were constructed; engineer for the Chemung River Commission, Corning, N.Y. in 1895 and 1896, on the construction of five miles of dikes, bridge extensions, and similar works; and engineer for the dam built across the Mohawk River at Little Falls, N.Y., in 1897 and 1898. He has designed and had charge of the construction of many other structures and hydraulic works.

He has held in succession the positions of Assistant Professor, Professor of Technical Mechanics, and Director of Rensselaer Polytechnic Institute, and since 1901 has been president and director of the institute. The honorary degree of E.D. was given him by Stevens Institute in 1905, and that of LL.D. by New York University in 1911.

He is a member of the American Society of Mechanical Engineers (Honorary Member 1931), the American Institute of Mining and Metallurgical Engineers, the Institution of Civil Engineers (Great Britain), and the American Philosophical Society; and is a Commander of the Legion of Honor (France), and a Commander of the Order of the Crown of Italy.

His published works include many contributions to the TRANSACTIONS of the Society and other technical journals, and a history of Rensselaer Polytechnic Institute, published in 1895 (second edition, 1914). He served as Director of the Society from 1899 to 1901, and as Vice-President during 1916 and 1917.

Personal Aspects of Society Membership

By Henry E. Riggs, M. Am. Soc. C.E.

Extracts from an Address Made Before the Detroit Section October 20, 1931

When a man gets to a point in life where he can look backward over a membership of more than forty years in the Society, the things that stand out in strongest relief are the personal friendships, the many perfectly splendid contacts with the master builders in our profession of builders, and many purely social matters that seemed of little moment when they occurred. The work of the Society is not in the least minimized by this fact. The splendid mass of literature of the profession originating there; the work of committees in establishing theories, methods, and standards of practice that have revolutionized engineering procedure; and the creation and constant maintenance of ethical standards which have resulted in the wonderful growth of the profession, have all contributed to the greatness of the Society and have been largely responsible for the general recognition of engineering as a learned profession that has come in these late years.

When I was in college in the early eighties, one of a small group of students interested in engineering, Dean Marvin of the University of Kansas urged those things upon us and urged us to aim for membership in this Society. He tried to give us ambition, and to plant in us the highest ideals, and he insisted on the need for constant and active association with engineers. Society membership was to be the ultimate and final measure of success.

Three or four years later it was my good fortune to be thrown in contact with two men who held the same notions of the fineness of Society ideals. I had a residency in Missouri on the Santa Fe Railroad. At the east end of it was the Sibley Bridge over the Missouri River. Octave Chanute was consulting engineer for the bridge, and John Findley Wallace resident engineer. For several months I spent three or four days a month working in Mr. Chanute's office. There I came really to know him for the gentle, thoughtful, and lovable man that he was—if you worked hard and were accurate. Mr. Wallace's camp was about three miles from mine. This was in western Missouri, too remote from Kansas City for frequent trips to town, so that I had a good opportunity to get really acquainted with him, too. It was my privilege, years later, to be associated with these two Past-Presidents and to firmly cement the friendship with my first two friends in the Society.

I think that I got my associate membership in the first week, if not on the very day, that I was eligible. I was as proud as Lucifer. A few days later I was in Ann Arbor and met Prof. Charles E. Greene on the street. He spotted my badge and commented on it, and in the next breath invited me to dinner. Shortly before dinner was ready he got a black bottle out of a cabinet and remarked that there were things that one never did with a student, but loved to do with a fellow engineer, and that he really counted a man's entrance into the profession from his membership in the Society.

These three men were the first of the Society's official family that I ever knew. In the forty years since then the Society has been the means of extending my acquaintance in the profession as nothing else could do. As I look back over the years, to my contacts with such men as Past-Presidents Whittemore, Chanute, Wallace, Noble, Hermany, Stearns, and Swain, and such members as Emil Kuichling, Ira O. Baker, and Leonard Metcalf—to mention only those who are gone—and a host of others of the salt of the earth, I realize that the greatest debt that I owe the Society is for the professional friendships of a lifetime.

Society work, like university work, is a wonderful thing for us old fellows because it keeps us in touch with the young men in the profession. By their affiliation with the Society, we have assurance that they propose to take their places as leaders tomorrow. This contact should do, and I think does do, for the younger members what it did for me in the way of helping to work out a sound and correct philosophy of professional life.

In my own youth and middle age I was too busy trying to make a living to attend many conventions. The convention had to come to my part of the world, and it had to come very close in order to have me present. The same things are true of the younger men today. But with four general meetings a year, many more young men are getting the social benefits of the Society.

Every man who is looking to the largest future for himself should attend these meetings whenever possible. The presence of large numbers of ladies in recent years has made Society meetings even greater reservoirs of friendship than they were in the old days. When a man has taken his wife to two or three of them he can be pretty sure that he will of necessity become a regular attendant at conventions.

The personal friendship of men in the same profession and same field of interest is the finest thing that can come to a man. It broadens him professionally; it enables him to exert an influence which he cannot possibly have if he keeps to himself; it gives him the opportunity to cooperate for the advancement of the profession; and above all it sweetens his life, and enriches it, and it draws this whole continent together by giving him friends from Maine to California and from Washington to Florida. Borrowing an expression I heard a few years ago, "Friendship gives us roses in December."

To you young men in particular I want to say: Carry on! This is not the only depression the world has ever had—nor the worst. In a year or two all will be well again, and the old bank book will have a good balance. Then it is up to you to better yourself professionally, and to do that, you must better the profession, and your city and your state. As you sow so shall you reap; as you put into the Society, so shall you take out. And when the snows come and your hairs whiten, may the Society give to you of the great abundance of her store of friendship that is so precious, and of the honors and the opportunity to work for her and the profession.

Howard Adams Carson, Honorary Member, Dies

Members of the Society will note with regret the death on October 26 of Howard Adams Carson, Honorary Member of the Society, at Malden, Mass., at the advanced age of almost 89 years. Although in his later years he has been in practical retirement, for a long period Mr. Carson was one of the best known civil engineers in active practice. His experience dates back to his graduation from the Massachusetts Institute of Technology in 1869.

Of special note was his connection, from 1894 to 1909, with the Boston Transit Commission, as Chief Engineer. During this period, the first electric car subway constructed in the United States, as well as the first submarine tunnel for similar service was constructed. When he left this work, the Boston Transit Commission paid honor to his "scrupulous honesty and impartiality, moderation and modesty in all things, faithfulness to the point of extreme self-sacrifice."

Among his other honors, Mr. Carson was a trustee of the Massachusetts Institute of Technology, and a former president of its Alumni Association and of the Boston Society of Civil Engineers. He was elected an Honorary Member of the Society in 1921. At the time of his death he shared the distinction of being one of the three oldest Honorary Members in point of election.

Appointments of Society Representatives

Leslie R. Ames, M. Am. Soc. C.E., represented the Society at the inauguration of Frank P. Graham as President of the University of North Carolina on November 11.

George W. Fuller, M. Am. Soc. C.E., has been appointed by the Society to represent it on Engineering Foundation, thereby filling the vacancy caused by the resignation of William H. Burr, M. Am. Soc. C.E.

J. E. Root, M. Am. Soc. C.E., has been appointed by the Society to serve as a member of the National Committee on Standards of Street Maintenance Economics.

Arthur S. Tuttle, M. Am. Soc. C.E., has accepted an appointment as Society representative on the United Engineering Trustees, Inc.

Sherman M. Woodward, M. Am. Soc. C.E., and LeRoy K. Sherman, M. Am. Soc. C.E., represented the Society at the Conference of the Department of Agriculture on National Land Utilization in Chicago, November 19–21.

Index to Civil Engineering, Volume I

With this issue, Volume I of CIVIL ENGINEERING comes to a close. It consists of 15 numbers, from October 1930 through December 1931, whereas succeeding volumes are expected to include only 12 numbers, all those for any one calendar year.

With this issue will also be found the index for the entire first volume. The difficulties of arranging such an index to include the present number are obvious, and yet it is felt that the advantage of having immediately available the complete material justifies the time and effort required to issue the index thus promptly.

For the benefit of those who desire to use this index in binding it should be noted that it can be readily detached from the remainder of the issue. By simply opening the staples which bind the various printed forms together, the section containing the index can be loosened and removed. The printing has been so arranged that the index will readily come out intact, without the necessity of shearing off separate sheets. It is hoped that this convenience will be of use.

In addition, provision has been made in case any member wishes to bind this first volume of CIVIL ENGINEERING in more than one part, for reasons of convenience and size. In such an event, he would naturally desire to have an index in each part. For the special use of such members, an ample supply of reprints of the index are to be run off as separates, and these will be furnished to members and subscribers at the regular reprint rate of 15 cents each.

In the arrangement of the index, thought has been given to its appearance in the bound volume. It is believed that the index might best be placed at the beginning of the volume. For this purpose, a first sheet has been added to the index itself, which will serve as a fitting and convenient title page to the bound volume. It is hoped that all these arrangements will operate to make the first volume of CIVIL ENGINEERING conveniently usable, and that they will facilitate the binding and retention of Volume I by many members, organizations, and libraries.

Engineers Cooperate to Relieve Unemployment

As one unit of President Hoover's relief army, the engineering societies have embarked on a program, the prime object of which is to demonstrate that they are "able and willing to pull their own weight." With ample evidence that engineers, as well as other classes of society, were caught in the present depression and that many of them had exhausted their resources, it was recognized that the first requisite was a comprehensive survey of engineers to determine the number of unemployed and the seriousness of the present need. President Hoover's recommendation that relief be made a community affair was accepted by engineers, and each locality has been asked to estimate its own problem and plan to solve it locally. It was pointed out that no superficial study of the situation would be adequate, because engineers are particularly reluctant to tell of their need, except to their closest friends. In order to find the quiet man who would never appeal for aid the most thorough survey must be made.

Typical of the manner in which the various units received the suggestion and acted upon it is the report from one Local Section of the American Society of Civil Engineers, which stated that two of its members were unemployed. So exact had been their survey that the Section was able to account for the two—one was on furlough and the other was on a part-time job. This committee conscientiously reported that four members living in an outlying district had not been heard from; but the machinery had been set in motion to find out about those four. Typical, too, of the general response, was the question which accompanied the report, "What shall we do now?"

The second suggestion which was made was that engineers should search out "made-work" projects in their localities, make estimates on these projects, and present the analyses to the local relief boards for consideration as emergency work; these projects to be so selected as to give value to the community as well as relief to the unemployed of all classes of labor. In some cities funds were collected from employed engineers, and men who needed immediate help were paid from this fund for making the work estimates. Thus a double service was rendered. In other places, engineers who had leisure time were glad to search out these jobs and make the estimates. Much talent in planning has been uncovered and communities are profiting by getting value from the money contributed for relief.

Engineering Unemployment Vigorously Attacked

A joint committee formed from the metropolitan (New York) sections of the four Founder Societies is giving close attention to the unemployment situation among engineers. Details of the development of this work may be of interest and help to those engaged in similar efforts elsewhere throughout the country.

A "Professional Engineers Committee on Unemployment" was organized on October 19, comprising about forty members of the four societies, and the organization was perfected as noted in the November issue. Notable progress is being made. A Subcommittee on Clearance maintains liaison with the general Emergency Relief Committee and with other similar organizations. Another Subcommittee on Organization and Operations is securing quarters, staff, and funds for the administrative work of the committee. Incidentally, it is planned to finance this administration through the four metropolitan sections in order that all funds contributed to relief may be expended undiminished for that purpose.

Other subcommittees cover publicity, vital statistics, plans, and opportunities in business and industry. Finally, there is a subcommittee to cooperate with the Engineering Societies Employment Service.

For the personnel of these committees, there has been very little trouble in securing the active services of outstanding engineers resident in the neighborhood of New York, many of whom have already established reputations as efficient workers in Society affairs.

A mass meeting of the engineers of the New York area, held in the auditorium of the Engineering Societies Building on November 9, was attended by more than 800 engineers. Those unable to give financial assistance were urged to contribute of their time and effort in raising money, in locating jobs, and in cooperating generally with the committee.

One of the speakers, William H. Mathews, a member of the local general relief committee, spoke of the committee's work with engineers. "Would that all societies and organizations we are working with were like the engineers," he said. "I have faith in the engineers that they will be among the leaders who will show us the way out of the depression."

There were a number of other prominent speakers, including Francis Lee Stuart, President of the Society; R. E. Tally, President of the American Institute of Mining and Metallurgical Engineers; Roy V. Wright, President of the American Society of Mechanical Engineers; O. H. Caldwell, chairman of the Metropolitan Section of the American Institute of Electrical Engineers; Willard T. Chevalier, M. Am. Soc. C.E.; and Harvey N. Davis, Mem. A.S.M.E., President of Stevens Institute of Technology.

Following this inspiring mass meeting an appeal for contributions was sent out to all members of the metropolitan sections of the four Founder Societies by the Professional Engineers Committee. Working in close harmony with the general unemployment relief committee of the city, the Professional Engineers Committee on Unemployment intends to care for all engineers within the metropolitan district who need assistance. Some are undoubtedly destitute; others are approaching that condition and will suffer if work does not soon appear; still others are unemployed but have some small resources which keep them going. Then there is a sizeable group of engineers out of work but not likely to require assistance. This latter group may welcome some sort of activity which will keep their minds occupied and perhaps aid their less fortunate brothers in the profession.

Of course the first effort will be applied to help the most needy. Some of these undoubtedly will come under the specifications for help by the general civic relief committee. The others cannot obtain help from that source, and must look to the Professional Engineers Committee on Unemployment and the funds which it hopes to collect.

Unemployed to Find Work for the Unemployed

Some of these funds, it is hoped, may be subject to loan. The usual method of disbursement, however, is intended to be in payment for engineering services in connection with "made-work," whether it be its discovery, planning, administrative layout, or

supervision. Engineers should be given an opportunity to apply their professional training and abilities as their share in the solution of the general relief problem.

A word as to the interpretation of the words "made-work"—in every community there is considerable work, particularly in the sanitary field, which ought to be done but which more often than not is postponed indefinitely. For example, vacant lots may contain trash which should be removed; stream beds may need weeding, cleaning, and perhaps paving or sodding; unsightly or mosquito breeding dumps may need leveling, filling, and draining. It will be noted that such work is not likely to displace the normal employment of labor on regular municipal projects, unless the community is already a "Spotless Town." Nevertheless, such work is progressive and constructive, and the money spent will not be wasted. Innumerable other examples of appropriate "made-work" may be found in practically every field of engineering practice.

To increase the efficiency of unemployment relief work and at the same time to absorb in professional work a large number of unemployed engineers, it is proposed that such engineers seek out suitable projects and do the necessary planning or designing for them, including the administrative layout. Then the project may be vigorously presented before the general unemployment relief committee for execution by labor paid by the general committee and under the supervision of the engineer who planned it, to be paid by the Professional Engineers Committee on Unemployment or other proper source.

Fraternal Spirit Developed

A development which was not anticipated is the inspiration resulting from the fine spirit of cooperation and helpfulness on the part of the engineers. A new atmosphere has been created which will not be dissipated for months to come—an atmosphere of fraternalism between all members of the profession. Those who are fortunate and have been able to help those who are unfortunate, have shared in the benefits of the spirit. This feature of the engineering societies' effort has been highly valued by the men of the various localities where the program has been inaugurated. It is a result which would be worth the effort if the original object were not self-sufficient.

Professional Records of Candidates for Office

An important event in the conduct of the affairs of the Society is the annual election of its officers. Except in the case of the President, who serves but one year, the terms of Society officers overlap so that new officers take the places on the Board of Direction made vacant by those who have served longest. By this means the experience gained in the administration of Society business and the establishment of Society policies is passed on to the less experienced officers. It is of interest to note in the following biographical sketches of candidates, not only their distinguished professional attainments but also their many years of unstinted effort for the advancement of the profession, evidenced in their work for the Society.

Herbert Samuel Crocker

Born at Haverhill, N.H., on June 20, 1867, Herbert S. Crocker graduated from the University of Michigan in 1889 with the degree of B.S. in Civil Engineering, and in 1919 the same University honored him with the honorary degree of Master of Engineering.

He began his career as a bridge draftsman, and gaining experience step by step was from 1901 to 1906 Assistant Erecting Manager of the Western Division of the American Bridge Company. In 1906 he went to Denver as Bridge Engineer for the Denver City Tramway Company and late in 1907 established a consulting office there. He designed and supervised the construction of all the important viaducts in Denver, including the 20th Street Viaduct and the Colfax-Larimer Viaduct. In 1909–1910 he was Engineer of the Board of Arbitration of the Grand Crossing Grade Separation in Chicago.

Commissioned a Major of Engineers in 1917 he was assigned to the Army Supply Base, Brooklyn, N.Y., as a constructing quartermaster on warehouses and piers totaling $32,000,000, and in 1918 was promoted to Lieutenant Colonel in the Quartermasters Corps.

From January 28, 1920 to May 10, 1921 Colonel Crocker was Acting Secretary of the Society. In 1921 he resumed his private practice in Denver and more recently he has also opened offices in Dallas, Texas. Since 1929 he has been a member of the Administrative Board of the American Engineering Council and represents the Society on the Assembly of the Council. He is a member of the Western Society of Engineers, the Colorado Society of Engineers, the Colorado Engineering Council, the Colorado Scientific Society, the Colorado Historical Society, and the New Hampshire Historical Society.

In 1919 and 1920 he was on the Society's Finance Committee and in 1920 was its chairman. He has served on the Library Committee, the Founder Societies Finance Committee, the Committee on Arrangements for the Society's 1920 Annual Convention and for the 1921 Annual Meeting. In 1920 he was a member of the Engineering Council's Committee on Military Affairs. He has served on the Board of Direction of the Society as Director from 1915 to 1917, and as Vice-President in 1919 and 1920.

Arthur Smith Tuttle

Born March 26, 1865, at Burlington, Conn., Arthur S. Tuttle was graduated in 1885 from New York University with the degrees of B.S. and C.E. From graduation to 1901 he served in various engineering grades on the development of the Brooklyn Water Supply. He then took charge of an investigation for the development of irrigation and water power in Hawaii. Since 1902 he has been connected with the Board of Estimate and Apportionment of the City of New York as Assistant Engineer, Deputy Chief Engineer, Chief Engineer, and since 1928, as Consulting Engineer.

As Chief Engineer he was the board's technical adviser in all matters relating to city planning, grade crossing elimination, zoning, street improvements, sewers, sewage treatment plants, and a variety of other engineering projects. Incidentally he was Chief Engineer of the Narrows Tunnel and was in charge of the administrative work in connection with it from 1921 to 1925, when the work was terminated by an act of the state legislature.

He has represented the city on a large number of special committees, of many of which he has been chairman. The most important committees were those on Traffic Relief, Transportation Facilities, Sewer Capacity, Main Drainage, Methods of Sewage Disposal in Use in Other Cities, Plans for Wards Island Sewage Treatment Works, Plans for the West Side Improvement (New York Central Railroad), Elimination of Grade Crossings on Atlantic Avenue, New York Approach to the George Washington Bridge, Jamaica Bay Improvement, and Aviation. Mr. Tuttle represented the city in the negotiations leading up to the agreement with the New York Central Railroad Company for the West Side improvement.

He is consulting engineer for, and member of the board of directors of, the National Meter Company, and invented the Premier water meter for use on large mains. He is the author of various technical papers delivered before engineering societies, was chairman during 1919 and 1920 of the Engineering Council's Committee on Classification and Compensation of Engineers, and is a member of the Advisory Board of *Municipal Sanitation*.

He has been Director and Treasurer of the Society, and president of the Metropolitan (New York) Section of the Society. He is a member of the American Water Works Association, the Municipal Engineers of the City of New York (former president), American Shore and Beach Preservation Association (director), Brooklyn Engineers' Club, Municipal Club of Brooklyn (former president), New York University Council, New York University Alumni Federation (former president), Engineer's Club, Arkwright Club, and Pleiades Club (president).

David Christiaan Henny

A native of Holland, D. C. Henny was born in Arnhem, November 15, 1860. He received his education at the Holland Polytechnic Institute of Civil Engineers, in Delft, where he graduated in 1881. After three years of railroad, drainage, and bridge work in Holland he came to the United States, where he engaged in railroad, water works, bridge, and tunnel construction work. In 1892 he became manager of the Excelsior Wooden Pipe Company, in San Francisco, at the same time carrying on a consulting practice, and in 1902 he took over the general managership of the Redwood Manufacturers Company.

Entering the U.S. Reclamation Service in 1905 as Supervising Engineer of the Pacific Coast Division, he had charge of the

Okanogan, Sunnyside, Tieton, Umatilla, Klamath, and Newlands projects. In 1910 he was appointed consulting engineer to the U.S. Bureau of Reclamation. He has advised on many projects, among them being the Hoover Dam. Mr. Henny has also maintained a consulting office in Portland, Ore., on irrigation, water power, flood control, and valuation work.

Devoting generously of his time to the work of technical societies, he has been successively president of the Technical Society of the Pacific Coast, of the Oregon Society of Engineers, and of the Oregon Technical Council. He has been a member of the Society since 1887, and from 1920 to 1922 he served on the Board of Direction of the Society as Director. He has served on the Society's Committee on Arch Dam Investigation and on the Committee on High Dams, and was chairman of the Committee on Irrigation Hydraulics. He is also a member of the Royal Institute of Engineers of Holland.

Edward Payson Lupfer

Born October 22, 1868, at Blain, Pa., E. P. Lupfer graduated from the Newton (Kans.) High School in 1889. From the spring of 1889 to the fall of 1890, he was Assistant Engineer in charge of construction on the Denver and Rio Grande Western Railway in Utah. From 1890 until the fall of 1892, he followed the construction of the Great Northern Railway from Havre, Mont., to the Pacific coast, as Assistant Engineer of Construction.

In 1892 he entered the University of Kansas as a special student and studied there until 1894. From 1895 to 1897 he was Assistant Engineer of Construction on the Denver and Rio Grande Western Railway in southern Utah. From 1897 to 1901 he held various positions on the Great Northern Railway, being Division Engineer of the Eastern Minnesota Railway in Minnesota from Deer River to Bemidji, in charge of 50 miles of construction during the year 1898, and Locating Engineer in the Columbia River and Okanogan country in the State of Washington in 1900.

From 1901 to 1903 he was Resident Engineer on the New York Central Railroad. From 1903 to 1904 he was Locating Engineer on the Buffalo and Susquehanna Railway, Wellsville to Buffalo; and from 1904 to 1907, Construction Engineer on the Buffalo and Susquehanna Railway, in charge of all new construction from Wellsville to Buffalo.

In 1907 he opened consulting and contracting engineering offices in Buffalo, N.Y., his company specializing in heavy construction work and bridges, both as consultants and contractors.

In 1925 he was appointed Chief Engineer of the Peace Bridge across the Niagara River, at Buffalo, and he superintended its construction. He is at the present time a Director and Chief Engineer of the Peace Bridge. He is actively engaged in consulting engineering and construction work and is interested in many civic organizations in Buffalo and in New York State.

He is a former president of the Buffalo Section of the Society, a director of the Chamber of Commerce of Buffalo, a director of the Buffalo Municipal Research Bureau, and a former president of the Buffalo Chapter of the Sons of the American Revolution. He is a registered Professional Engineer in the State of New York. Mr. Lupfer was appointed a Director of the Society in April 1930, to fill the vacancy caused by the death of George H. Norton.

John Herbert Gregory

Born August 7, 1874, in Cambridge, Mass., J. H. Gregory graduated from the Massachusetts Institute of Technology in 1895 with the degree of Bachelor of Science in Civil Engineering. Ever since graduation he has been actively engaged in the design and construction of sanitary engineering works, especially water supply, water purification, sewerage, and sewage disposal works. Among the more important cities with which he has been connected are Boston, New York, Albany, Philadelphia, Columbus, Chicago, Detroit, Toronto, Montreal, and Baltimore.

From 1911 to 1917 he was a member of the firm of Rudolph Hering and John H. Gregory, Consulting Engineers, New York; and since 1919, in addition to his consulting practice, he has been a member of the faculty of the Engineering School of Johns Hopkins University. In 1920 he was appointed Professor of Civil and Sanitary Engineering there.

In 1910 he was awarded the Thomas Fitch Rowland Prize for his paper entitled "The Improved Water and Sewage Works of Columbus, Ohio"; and in 1930, in conjunction with C. B. Hoover and C. B. Cornell, he was awarded the James Laurie Prize for the paper entitled "The O'Shaughnessy Dam and Reservoir."

He is a member of many national and local engineering societies and associations and is a former president of the Baltimore Section of the Society.

Henry Earle Riggs

Born on May 8, 1865, in Lawrence, Kans., Henry E. Riggs was graduated in 1886 from the University of Kansas with the degree of A.B., after a five-year literary and engineering course. In 1910 he received the degree of C.E. from the University of Michigan. On graduation from the University of Kansas he entered railway service as axman on the B. and M. Railroad in Nebraska. In the fall of 1887 he entered the service of the Atchison, Topeka and Santa Fe Railroad. From March 1, 1890, to January 1, 1896, he was Chief Engineer of the Ann Arbor Railroad. From 1896 to 1912 he was a member of the Riggs and Sherman Company of Toledo, Ohio, engaged in design and construction of sewerage, water works, paving, electric railway and industrial railroads.

From 1912 to 1930 he was Professor and head of the Department of Civil Engineering of the University of Michigan. On June 30, 1930, he retired with the title of Honorary Professor of Civil Engineering.

In 1900 he was one of the two principal assistants of M. E. Cooley on the Michigan appraisal of railroads, and since then has devoted the major part of his attention to problems of valuation and depreciation. He has acted as consulting engineer on valuation matters for the states of Michigan, New York, and Georgia; for railroads, including the New York Central System, the Illinois Central System, the Norfolk and Western, the Virginian, the Union Pacific, the St. Louis-San Francisco, and the Pere Marquette; and for a number of municipalities.

He was a member of the Society's Special Committee on Principles and Methods of Valuation. He has written a number of papers and magazine articles on valuation and depreciation, and is the author of a book on depreciation.

He is a member of the American Railway Engineering Association, the Michigan Engineering Society (president, 1901), the Detroit Engineering Society, the Society of American Military Engineers, and the Society for the Promotion of Engineering Education. He is a former president of the Detroit Section of the Society.

Melvin Lorenius Enger

Born May 5, 1881, in Decorah, Iowa, M. L. Enger received his B.S., C.E., and M.S. degrees in 1906, 1911, and 1916, respectively. From 1906 to 1907 he was in the Bridge and Building Department of the Chicago, Milwaukee, and St. Paul Railway. Since 1907 he has been a member of the engineering faculty of the University of Illinois, teaching mechanics, hydraulics, water supply, and sewerage. In 1926 he was made head of the Department of Theoretical and Applied Mechanics. Mr. Enger is the author of technical papers on hydraulics and the transmission of pressure through granular materials.

He is a former president of the Central Illinois Section of the Society, and is a member of the following organizations: the Illinois Society of Engineers (president, 1929); the American Water Works Association (chairman, Illinois section, 1930); the

Official Nominees—1932

For President, Herbert S. Crocker, of Denver
For Vice-President, Zone I, Arthur S. Tuttle, of New York
For Vice-President, Zone IV, D. C. Henny, of Portland, Ore.

For Directors:

District 3, E. P. Lupfer, Buffalo, N.Y.
District 5, John H. Gregory, Baltimore, Md.
District 7, H. E. Riggs, Ann Arbor, Mich.
District 8, M. L. Enger, Urbana, Ill.
District 9, Robert Hoffmann, Cleveland, Ohio
District 12, J. C. Stevens, Portland, Ore.
District 16, E. B. Black, Kansas City, Mo.

Results of the final ballot will be announced at the Annual Meeting in January 1932

American Society for Testing Materials; and the Society for the Promotion of Engineering Education.

Robert Hoffmann

Born in Cleveland on December 16, 1865, Robert Hoffmann graduated from Hiram College and from the Case School of Applied Science and holds the degrees of M.S., C.E., and Doctor of Engineering (honorary).

In 1893, Mr. Hoffmann entered the employ of the Cleveland City Engineer's office, and received advancement through various positions, becoming Assistant Chief Engineer in 1904. He was appointed Chief Engineer in 1907 and continued in that capacity until September 1930, the title of the position changing in the meantime to Commissioner and Chief Engineer of the Division of Engineering and Construction.

As Chief of the Engineering Division he had general direction of all the city's planning and construction work in connection with such projects as pavements, sewers, bridges, grade crossing elimination, river and harbor work, sewage treatment plants, and other similar engineering work. His activities also included city planning projects and membership on an advisory commission in connection with the city's water supply and harbor development.

Since September 1930, Mr. Hoffmann has continued in the employ of the city as Consulting Engineer on Public Works.

He is a member and former president of both the Cleveland Section of the Society and the Cleveland Engineering Society. He is a member of the Cleveland Chamber of Commerce, the American Society of Municipal Engineers, the American City Planning Institute, and the International Association of Navigation Congresses. He is also a member of the Board of Trustees of Hiram College, and of the Corporation of the Case School of Applied Science.

John Cyprian Stevens

Born in Moline, Kans., on January 9, 1876, J. C. Stevens served in the Philippines during the Spanish-American War. In 1905 he graduated from Nebraska State University with the degree of B.S., and in 1928 he obtained the professional degree of C.E.

Mr. Stevens has been Assistant State Engineer of Nebraska; Assistant Engineer, U.S. Reclamation Service; and Engineer, U.S. Geological Survey on water supply investigations in Nebraska, Colorado, and South Dakota. For five years, beginning in 1905, he was District Engineer of the U.S. Geological Survey in charge of the Columbia River Basin.

While he was practicing privately in Portland, Ore., the Pearson Engineering Corporation of New York sent him to Barcelona, Spain, for two and one half years as Project Engineer on the huge Seros and Gerri Hydro-electric Project. On his return to the United States he completed the design and construction of the West Okanogan Valley Irrigation District works.

In 1916 he reestablished a consulting office in Portland. In 1920 he formed a partnership with R. E. Koon, M. Am. Soc. C.E., which he still maintains. The practice of the firm is devoted to the design and construction of dams, water supply, and irrigation projects, hydro-electric power plants, and sewage disposal and water supply systems.

The contributions of Mr. Stevens to engineering literature have been generous. He has been a member of the Oregon State Conservation Commission, a member of the committee that drafted the Oregon Water Law, and vice-chairman of the Super-Power Survey Committee of the Pacific Northwest. At present he is a member of a consulting board for the Waterfront Development Project of Portland, a $12,000,000 project. He is member of the American Institute of Electrical Engineers, a former president of the Professional Engineers of Oregon, and the secretary of the Society's Special Committee on Irrigation Hydraulics.

Ernest Bateman Black

Born January 13, 1882, in Mt. Sterling, Ill., E. B. Black was graduated in 1906 from the Engineering School of Kansas State University, and granted the degree of Civil Engineer by the same university in 1924. For a number of years prior to entering the university he was associated with his father on land and irrigation surveys in western Kansas and Oklahoma. While a student he served for four years as an instructor in mechanical drawing.

In 1905 and 1906 he was an assistant masonry inspector for the Atchison, Topeka, and Santa Fe Railway on second track construction in Kansas and Illinois. From 1906 to 1909 he was an assistant engineer with the Riggs and Sherman Company, Consulting Engineers, of Toledo, Ohio, and was engaged on the location of electric railways, and the design and supervision of construction of water, sewerage, and paving projects in Indiana, Ohio, and Michigan.

From 1909 to date he has been in private engineering consulting practice in Kansas City, first with the J. S. Worley Company, and then with its successors, Worley and Black, and Black and Veatch. These firms have specialized in water supply, water and sewage treatment, power projects, and valuations, and have served numerous public and private clients throughout the Middle West and Southwest.

In 1917 Mr. Black was Construction Engineer for the War Department in the construction of Camp Pike, Ark. Commissioned in December of 1917 as a Captain in the Signal Corps, he served first as Chief Engineer of the War Credits Board, and later as Engineer of Section B, Construction Division of the Army, and was discharged from the service in December 1918, with the rank of Major, Air Service, Aircraft Production.

Since 1920, his principal work has been in connection with valuations and engineering reports. In this period he has served various cities and private clients in Texas, Oklahoma, Kansas, and Missouri, particularly on gas rate matters. At the present time he is retained by the Corporation Commission of Oklahoma, the Public Service Commission of Kansas, and a number of Illinois cities, in gas valuations and rate matters.

He is a member of the American Institute of Consulting Engineers, the American and New England Water Works associations, and a number of state engineering societies, and is now president of the Kansas City Engineers' Club. He is a former president of the Kansas City Section of the Society, and has represented the Kansas Engineering Society on American Engineering Council for one year as member of the Council's Administrative Board.

Annual Meeting Program in January Issue

No complete program of the 1932 Annual Meeting will be published and sent out to individual members. Instead, the official outline of events for this Meeting will appear in the next, that is, in the January issue of Civil Engineering. This announcement is being made in advance to relieve any apprehension of members, who may otherwise misunderstand their failure to receive the usual separate folder.

Certain distinct conveniences mark this new plan for issuing these programs. The general set-up of Civil Engineering lends itself to a display of the features of interest to members, who may wish to plan in advance to attend the Meeting. Even those who have no expectation of coming to New York in January will be glad to learn of the interesting features such a program will contain. As a result they will await with greater anticipation the publication of abstracts of the various papers in the March issue.

This new plan also has the advantage of making it possible to devote more space to the announcements in Civil Engineering. In the past, because of the separate folder issued to all members, it has not seemed advisable to cover the Meetings fully in that publication. This has been a detriment inasmuch as, to many members, it is more convenient to study the program in the larger issue than to depend on a small and too easily misplaced folder.

Perhaps the greatest advantage of the new plan is that it places in permanent record the official layout of any Meeting. As long as Civil Engineering is retained by a member, so long will he have this official record. To those who intend to bind their volumes, this will be a convenience. Doubtless some members in the past have kept a file of the small programs, but in so doing there are obvious disadvantages, which will be entirely overcome by the new arrangement.

Separate copies of the program will be available at the time of the Annual Meeting. These may be readily folded to a convenient pocket size. Those members who feel that they need or desire advance copies may secure separate programs on request to Headquarters.

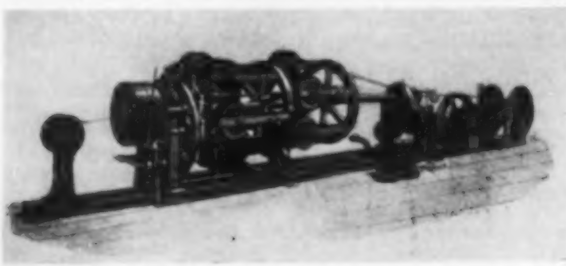
Arrangements are being made to furnish railroad certificates and advance registration cards by mail to all members individually. In this way it is felt that all the advantages of the old plan will be retained, while the economy and convenience of the new will be added. To repeat—this innovation will have its first trial in the January 1932 issue of Civil Engineering. Look there for your official Annual Meeting program.

A Preview of Proceedings

Wire ropes play such an important part in engineering design and construction that a prominent place in the December issue of PROCEEDINGS *is given to an interesting and useful discussion of the history and development of the making of wire rope, including a presentation of new formulas for designing both stationary and moving parts. A second paper contains a complete technical history of the design and construction of the Lake Champlain Bridge, which in 1930 was awarded a Phebe Hobson Fowler Award as an outstanding example in engineering architecture. The third paper to appear in this issue deals with the problems facing the steel bridge erection engineer in terms of plant, methods, and equipment. A fourth paper describes methods and equipment used in driving a subaqueous tunnel under the East River, New York, by shield methods.*

A New Wire Rope Formula

Many facts not commonly known concerning the history and development of wire rope are described in an intensely interesting manner by Fred C. Carstarphen, M. Am. Soc. C.E., in his paper on the "Effects of Bending Wire Ropes." The article is extensive



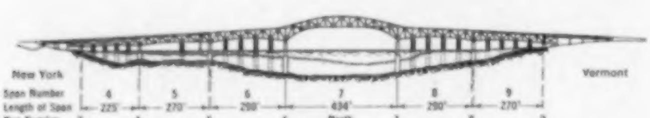
A 12-Bobbin Stranding Machine for Wire Rope

in its scope, beginning with a tabulation of fundamental definitions applying to wire rope, and extending into a presentation of the results of research (theoretical and laboratory) to support the author's thesis. Stranding machines are described in detail. Characteristics of cables in general, and of various cables in particular, are listed. A large part of the paper is concerned with the subject of analyzing strengths of wire rope. The author also presents a résumé of all the more important well known formulas for determining bending stresses in wire rope. Formulas by Rankine, Hewitt, Reuleux, and Chapman are listed.

A most important phase of the paper is the presentation of a new formula which departs from usual practice in including total service stress, tension, diameters of the rope and sheave, respectively, and the rope velocity. It is hoped that this presentation will elicit the extensive discussion that it deserves. For his paper, "Aerial Tramways," in Vol. 92 of TRANSACTIONS (1929), Mr. Carstarphen was awarded the Arthur M. Wellington Prize in 1929.

Lake Champlain Bridge

A complete technical history of the planning, design, and construction of the bridge across Lake Champlain has been prepared by Charles M. Spofford, M. Am. Soc. C.E., for the December number of PROCEEDINGS. This is another professional record of a noteworthy engineering accomplishment in the present age. On October 10, 1929, Professor Spofford appeared before the Structural Division of the Society at its Fall Meeting in Boston, Mass. His description of the bridge as given at that time would serve as a fitting summary of the salient features of the present



Elevation of the Lake Champlain Bridge

paper. That talk was reported in PROCEEDINGS for December 1929.

Heretofore Lake Champlain, for a length of 120 miles, has constituted a serious barrier to free intercourse between the states of Vermont and New York. It has been possible to operate ferry lines only in the season of open water, which is approximately eight months of each year. Occasionally it has been possible to operate routes across the ice, but from every point of view the need for a bridge crossing has been obvious for many years.

The first definite step toward this end was taken in 1923 when the Vermont General Assembly created a commission to inquire into the feasibility and possibility of joint action with New York State to bridge the lake. On August 2, 1927, a joint commission of the states of Vermont and New York appointed the firm of Fay, Spofford, and Thorndike to make preliminary studies and estimates of various types of bridges and to place contracts for borings. The first contract for the construction of the bridge was awarded May 18, 1928; and 15 months after, on August 26, 1929, the bridge was opened to traffic.

To structural engineers in general not the least interesting part of this paper will be the author's clear presentation of problems involving the financing of the bridge and the fixing of toll rates. Another part of the paper involves a discussion of the various types of bridges considered and the reason for the adoption of the final design. The bridge is a continuous truss structure, and the lack of statical determinability in this type required additional mathematical investigations on the part of the designers. Forces were determined by the well known method of least work, which has been described in detail in many recent works, notably in *The Theory of Structures*, by Professor Spofford himself.

Construction Plant and Methods of Erecting Steel Bridges

In his compact and readable article on "Construction Plant and Methods for Erecting Steel Bridges," A. F. Reichmann, M. Am. Soc. C.E., Assistant Chief Engineer of the American Bridge Company, has classified structures more from the standpoint of the problems facing the erection engineer than from that

A Bridge Erection Problem
Heavy A-Frame Deck Track Traveler, Cantilever Erection

of type of structure. In a clean-cut manner he deals with broad general principles applicable in some degree to all bridge erection problems rather than with specific details.

The paper begins with a short appraisal of the influence of the type and the location of the structure on the methods of erection. The factors that influence this phase of the problem are character of the terrain to be crossed, distance from the center of supply for labor and materials, available space for storage yards and necessary shops, connection with railroad facilities, power and fuel supply, as well as the height of the bridge above the water or the ground.

Ample consideration is given to the problem of maintaining traffic during construction as applied to three specific cases: when the bridge crosses a river; when it crosses a railroad or a highway;

and when there is already a railroad or highway in operation on the bridge structure itself. The manner in which these elements modify selection of equipment and construction methods is treated by Mr. Reichmann with specific reference to the effect of floods, high water, wind, and extremely hot or cold weather.

Another section of the paper deals with the limitations and handicaps imposed by time on the construction of a bridge. The time factor is governed by at least three influences: the time of completion stated in the contract; the seasonal effect; and the time of coordination required with other agencies on the job, such as those constructing the foundation. In dealing with construction plants and equipment the author describes the peculiar uses

Another Bridge Erection Problem
Top Cord Traveler, Temporary Steel Bent Support, Pile Driver Driving Support for Another Temporary Bent

of the more primary elements of mechanical equipment, such as locomotive erecting cranes, derrick cars, derricks, travelers, and cableways. The paper does not open for discussion the subject of the vast number of special tools and equipment used in bridge construction.

Fulton Street East Side Tunnel, New York

The contract for the Fulton Street Tunnel, New York, N.Y., described in the paper by Miles I. Killmer, M. Am. Soc. C.E., was let in November 1927, to the Mason and Hanger Company, Inc., of which Mr. Killmer is Manager. The two tubes comprising this tunnel were constructed by the shield method under com-

Excavating Top Heading
Fulton St. Subway Under East River, New York

pressed air. By constructing a shaft in Manhattan and another in Brooklyn, it was possible to drive eight headings at the same time. The paper describes the equipment used and the methods of using it. Considerable attention is given to the units in the power house as well as to the construction and erection of shields.

The papers by Mr. Killmer and Mr. Reichmann in this month's Proceedings, in effect are almost in the nature of a two-paper symposium on the subject of construction plant and methods. The types of construction described by each are quite different, one being in the field of bridge construction and the other in the field of tunnel construction. Engineers will get from Mr. Killmer's paper a description of tunneling methods as applied to a specific job. From Mr. Reichmann's paper they will get a description of bridge erection as applied generally on all jobs.

News of Local Sections

Central Ohio Section

At the meeting of the Central Ohio Section, held on October 22, the report of the Functional Expansion Program Committee on the question, "Is the U.S. Government to support and promote governmental activities in destructive competition with its own citizens or shall it encourage and stimulate individual initiative and progress?" was presented by E. G. Bradbury, chairman. Later, President Lee described the work of the Ohio Stream Flow Survey, illustrating his talk with motion pictures of the manner in which the work is carried on and the equipment used.

Cincinnati Section

The season's first bi-monthly meeting of the Cincinnati Section was held on October 12. The first speaker of the evening was H. M. Waite, Vice-President of the Society, who brought back a report from the Fall Meeting of the Society in St. Paul. The second speaker, L. Segoe, well known for his city and regional planning activities, gave a most interesting discussion of regional planning in general and in its application in Hamilton County and vicinity. There were 31 members and guests in attendance.

Cleveland Section

A meeting of this Section was held on Tuesday noon, October 6. Following the business session, an interesting talk was given by Ralph Harding, on the routes proposed for the Main Street Bridge.

Detroit Section

On October 30, the Detroit Section held its annual meeting at which the following officers were elected for the coming year: Lawrence G. Lenhardt, President; Perry A. Fellows, First Vice-President; Harry A. Shuptrine, Second Vice-President; and Forrest E. Weber, Secretary-Treasurer.

Illinois Section

The luncheon meeting of the Illinois Section of the Society was devoted to a discussion of the employment situation as it relates to engineers. Mr. Nethercut was called upon by President Hansen to outline the relief measures undertaken by the Western Society of Engineers. Then the meeting was addressed by Mr. Wilson, representative of the Section on the committee which directs the activities of the employment office maintained by the Western Society of Engineers and the four national societies. After this a description of the Engineers' Committee on Unemployment Relief was given by William S. Monroe, who is the chairman of this group.

Los Angeles Section

A well attended meeting of the Los Angeles Section was held on October 15. An illustrated talk on a subject of paramount interest to this locality, the Hoover Dam, was given by Walker R. Young, Chief Construction Engineer of the U.S. Bureau of Reclamation for Hoover Dam. He presented a very interesting account of the history of studies made of the Colorado River, leading up to the selection of the site for the dam now under construction. There were 235 members and guests in attendance.

The Sanitary Group held its regular monthly meeting on Wednesday night, November 4. At this meeting the various types of water meters were discussed by R. W. Sparling, and the new 6-million gallon filtration plant at Wilmington was described by J. G. Francis, Designing Engineer, Department of Water and Power, City of Los Angeles. Also Dr. Carl Wilson, Director of Sanitation, Department of Water and Power, City of Los Angeles, dis-

cussed the "Latest Developments in the Use of Ammonia and Activated Carbon in Water Purification."

Maryland Section

On Thursday evening, October 22, after an informal dinner, John F. Stevens, Past-President of the Society, Chief Engineer of the Panama Canal during the early stages of its development, and former chairman of the Commission of Railway Experts to Russia, addressed a joint meeting of the Maryland Section, the Engineers Club of Baltimore, and the affiliated national engineering societies on "The Canal Situation." His discussion centered upon the economic and practical conditions of operation as they exist today, or may be affected by future conditions. His analysis of the situation was timely and thorough.

Metropolitan Section

Approximately 500 members of the Section attended the meeting held on November 18 in the Engineering Societies Building, at which subway construction was the chief topic of discussion. Begun in 1900, New York's first subways were put into operation in 1904. Since that time the old system has been extended and a new system built so that the total investment in construction, operating equipment, and real estate exceeds one billion dollars. Describing the flexibility of the steel-frame shallow-type subway in use in New York, A. I. Raisman, Chief Designing Engineer, Board of Transportation, paid tribute to the far-sighted standard set up by Gen. William B. Parsons, first Chief Engineer of the system.

After an instructive exposition of the many details of complicated station layout, river crossings, ventilation, equipment, and the recent extensive use of mercury arc rectifiers to convert the 60-cycle current furnished by the power company to direct current for the operation of trains, the scene was shifted to Philadelphia. Subway construction in that city was briefly pictured by Charles H. Stevens, Chief Engineer; and other discussion of the main paper was contributed by Robert Ridgway, Chief Engineer of the Board of Transportation of New York, and by Col. J. R. Slattery, Deputy Chief Engineer of the Board.

The Section had as a guest Prof. Karl E. Hilgard, Consulting Engineer of Zurich, Switzerland, a corporate member of the Society since 1890. He is revisiting the United States after an interval of 11 years.

Milwaukee Section

At the meeting of the Milwaukee Section on October 28, the secretary made a report on the St. Paul Meeting of the Society, and Professor Roberts reported on the Student Section's Conference which took place at the St. Paul Meeting.

Philadelphia Section

The subject of the October 21 meeting of the Philadelphia Section was "The Port of the Delaware River." An inspection trip was made of the harbor, of the Pennsylvania Railroad's Girard Point grain elevator, and of the Point Breeze Plant of the Atlantic Refining Company on the Schuylkill. At the technical meeting, after dinner, John Meigs, consulting engineer, and chairman of the meeting, showed numerous slides of Philadelphia's large group of municipal piers. Moving pictures of 45-ton railroad passenger cars being loaded fully assembled were shown by Charles H. Gant, General Manager of the Port and Secretary of the Board of Harbor Commissioners, Wilmington, Del. Other pictures showing the handling aboard ship of loads as high as 124 tons at one of the Philadelphia municipal piers were presented by George R. Edmunds, of the Philadelphia Port Traffic Bureau, who spoke in place of Carroll R. Thompson, Chief Engineer of the Philadelphia Department of Wharves, Docks, and Ferries.

Pittsburgh Section

On July 20, officers for the Pittsburgh Section were elected as follows: John Farris, President; P. J. Reich, Vice-President; and Nathan Schein, Secretary-Treasurer.

Seattle Section

After the summer vacation, meetings of the Seattle Section were resumed on September 29. The speaker of the evening was Samuel H. Hedges, President of the Washington State Chamber of Commerce, who has just returned from a tour of inspection of the Columbia Basin Project with the House Reclamation Committee. He outlined the proposed program for this great development.

An address by Dean R. G. Tyler, of the College of Engineering, University of Washington, was the feature of the Section's meeting held on October 27. His talk was illustrated with slides of apparatus to determine the stream flow of the Hudson Suspension Bridge and slides showing interesting side lights on life in Holland, France, and Germany. There were 33 in attendance.

St. Louis Section

The St. Louis Section held its regular meeting on October 26, with 28 members and 2 guests present. An informal illustrated talk on "What Goes on Inside the Plant" was given by George T. Moore, Director of the Missouri Botanical Gardens. Later, H. F. Thomson, who attended the St. Paul Meeting as alternate for W. W. Horner, made an informal report relative to the meeting and his attendance at the Student Chapter conference, held at that time.

Tacoma Section

The October 13 meeting of the Tacoma Section was held at Olympia, Wash. An interesting talk was given by C. J. Bartholet, State Hydraulic Engineer, on the activities of his department and problems arising from construction of hydro-electric plants that interfere with the annual run of salmon to the upper reaches of the rivers and streams of the state. Then C. T. Pollack, State Supervisor of the Fisheries Department, spoke on the fishing industry, described the latest design of fish ladders now being constructed, and touched on the operation of fish hatcheries and the effort his department is putting forth to increase the salmon runs. There were 60 members and guests present.

Texas Section

On Friday, October 23, the Texas Section met in Laredo. Four very excellent papers were presented as follows: "Concrete and Gunite Lining of Irrigation Canals in the Lower Rio Grande Valley of Texas," by Alfred Tamm; "International Engineering Problems of the Rio Grande," by Col. S. F. Crecelius; "The early Art of Terrestrial Measurement and Its Practice in Texas," by E. P. Arneson; and "The 1931 Highway Traffic Census in Texas," by John A. Focht. After the technical meeting the annual business session was held, at which time the following officers were elected for the next year: T. E. Huffman, President; E. P. Arneson, First Vice-President; C. M. Davis, Second Vice-President; and J. T. L. McNew, Secretary-Treasurer. In the evening the annual banquet meeting was held, immediately after which 57 members and their wives left by chartered Pullman for Monterey, Mex., where on Saturday they were entertained by the Engineers' and Architects' Club.

Virginia Section

The Virginia Section reports the resignation of its Secretary-Treasurer, Albert C. Dunn, whose headquarters have been moved from Richmond. The Board of Directors has appointed P. A. Rice to fill Mr. Dunn's unexpired term.

Student Chapter News

Case School of Applied Science Student Chapter

As a result of Professor Neff's resignation from the faculty of Case School of Applied Science, Fred L. Plummer, Chairman of the Committee in Charge, has been appointed to act as adviser to the Student Chapter.

College of the City of New York Student Chapter

At a meeting of the Chapter held on October 22, the chief speaker was Ole Singstad, Consulting Engineer for the Port of New York Authority and Engineer in Charge of Tunnel Construction for the Board of Transportation. Mr. Singstad's talk dealt with tunnel construction, on which he is an authority.

A meeting on October 9 was addressed by John S. Peck, of the college faculty, on the subject of "Engineering Research."

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for January

For the January issue of Civil Engineering an attractive list of articles of both technical and general interest is being prepared. Russia is not usually thought of as a region in which irrigation and cotton growing are practicable. But for thousands of years Russian Turkestan has been irrigated with waters from melting glaciers. Fifty years ago cotton seed from the United States was introduced to encourage cotton culture. During the past two years, Arthur Powell Davis, Past-President of the Irrigation Society, has been in Turkestan advising the Soviet Government on plans to further increase the efficiency of the existing irrigation systems. His article on the subject can be considered as an authoritative exposition of the problems awaiting solution there.

Another article will deal with the construction of an engineering model of the Calderwood Dam to a scale of 1:50. This is by A. V. Karpov and R. L. Templin, Members Am. Soc. C.E., who have had charge of the design and testing of the rubber litharge model for the Aluminum Company of America. They describe important developments in the use of models for the design of dams. In this litharge model, built of a material having a low modulus of elasticity and at the same time a specific gravity equal to that of concrete, deflections caused by variations in the water surface equal to an eighth of an inch can be easily measured. Special attention has been given to simulating actual foundation conditions.

How the basic sea level datum for elevations in the United States is determined is the subject of a third article, by H. A. Marmer, M. Am. Soc. C.E., of the U.S. Coast and Geodetic Survey. A primary determination of mean sea level requires the averaging of hourly readings over a 19-year cycle, but Mr. Marmer explains how this period can be safely reduced to one month if results within 0.1 ft. are sufficiently accurate.

The Canadian Government has found the aeroplane a useful and economical piece of equipment for reconnaissance work in selecting triangulation stations for geodetic surveys. The Director of the Geodetic Survey of Canada, Noel J. Ogilvie, M. Am. Soc. C.E., is the author of an article explaining the use of a special plane table which can be mounted in the cabin of an airplane. For summer work planes equipped with pontoons for landing on lakes, which are numerous in Canada, are successful, while work which is continued during the winter requires planes with skii-type landing gear. Such saving in time results from the aerial method that parties to build towers and prepare stations can be put into the field at least a year earlier than if reconnaissance were done by ground methods.

"How Traffic Surveys Are Used in Solving Highway Problems" is the title of an article by Bruce Greenshields, Assoc. M. Am. Soc. C.E. Backed by the indisputable facts and detailed information supplied by traffic surveys, highway officials can secure, execute, and plan long-term programs.

Other articles of wide interest to readers will appear in the January issue. One will describe the travel habits and the control of sewage odors, and another will explain a novel but effective method of using an outside coat on concrete structures for decorative purpose. In this process the surface coat and the concrete of the mass are poured simultaneously.

Rensselaer Names Buildings for Graduates

Rensselaer Polytechnic Institute recognizes some of its graduates who have become prominent in engineering or science by naming buildings after them. Among the dormitories named in this way are White, Cooper, Buck, Macdonald, Roebling, Pardee, and Caldwell. The institute is now building two new dormitories containing ten separate units, each one of which will be named after a railroad president, a graduate of the institute, as follows: Cassatt, Voorhees, Matsmoto, Hirai, Miller, Roberts, Walter, Clement, Waite, and Hearne. The names used are in every case those of men not now living

On the faces of the new Architectural Building, used for the first time this year, are cut stone tablets giving the names of 15 of the most eminent American architects not now living, as follows: Jefferson, McComb, Bulfinch, Latrobe, Hooker, Mills, McIntyre, Renwick, Richardson, McKim, Goodhue, Sullivan, Upjohn, Hunt, and Burnham. In thus honoring its noted graduates, Rensselaer Polytechnic Institute is perpetuating the results of its own work.

COMING EVENTS

American Society of Civil Engineers
Annual Meeting Convenes in New York
January 20, 21, 22, 1932

American Society of Mechanical Engineers
Annual Meeting, New York, November 30–December 4

Highway Research Board, National Research Council
Eleventh Annual Meeting, Washington, D.C., December 10, 11

National Rivers and Harbors Congress
Annual Congress, Washington, D.C., December 8, 9

Wisconsin's Board of Examiners of Architects and Engineers

Registration of professional engineers has been growing to such an extent that in 25 states civil engineers are now required to be registered. In Illinois the law applies only to structural engineers, and in New Mexico and Texas it applies only to land surveyors. Hawaii, Porto Rico, the Phillipines, and seven provinces of Canada also require that engineers be registered. The list of states having a registration law is becoming so long that it is less formidable to mention states in which such laws are not in operation.

During the past year the legislative bodies of two states have adopted a registration law, those of Kansas and Wisconsin. In Wisconsin the architects and the civil engineers saw 11 years of cooperative effort crowned with success when the registration law for architects in that state was amended to include civil engineers as well.

By the provisions of the Wisconsin law, the Board of Examiners of Architects and Civil Engineers consists of nine members: the state architect, the state engineer, the dean of the college of engineering of the state university, three architects, and three engineers. A significant provision is that the three architects and the three engineers must be appointed from lists consisting of two or more names for each position to be filled, submitted by the architectural and engineering societies of the state. The dean of the college of engineering is the chairman of the board.

The appointing body is the State Industrial Commission, which has announced the following appointments: architect members, J. J. Flad, H. A. Foeller, and G. J. DeGelleke; engineer members, James L. Ferebee, M. Am. Soc. C.E., and Robert C. Johnson and L. F. Van Hagan, both Associate Members Am. Soc. C.E. The ex-officio members of the board are: F. E. Turneaure, M. Am. Soc. C.E., dean of the College of Engineering, University of Wisconsin; C. A. Halbert, State Engineer; and Arthur Peabody, State Architect.

Of the engineer members, Mr. Johnson, Chief Engineer of the Immel Construction Company of Fond du Lac, is the son of the late Prof. J. B. Johnson, at one time dean of the College of Engineering of the University of Wisconsin and well known as the author of engineering textbooks on the strength and mechanics of materials. The chairman of the engineering division of the board, Mr. Ferebee, is Chief Engineer of the Sewerage Commission of Milwaukee County; Professor Van Hagan, chairman of the Civil Engineering Committee, is head of the Department of Railway Engineering of the Engineering College of the state university. The board members serve without compensation but they are reimbursed for necessary expense.

For a number of years the Society has had a Model or a Uniform Registration Law which it has recommended for adoption in those states considering such a law, but until recently it had taken no stand either for or against the desirability of such a law. However, at its Tacoma meeting in July of this year, the Board of Direction voted that it "approves of registration of engineers."

A Method of Making Short Traffic Counts

IN 1924 the Outdoor Advertising Association of America established at the University of Wisconsin a research fellowship named the Barney Link Fellowship. Its purpose is to study problems of marketing, circulation, and landscaping in connection with advertising.

City planners, traffic directors, manufacturers of traffic control signals, chambers of commerce, chain stores, automobile associations, highway commissioners, park superintendents, zoning commissions, outdoor advertising plant owners, police departments, and safety bureaus have all given the traffic problem thought and study, but each has approached the difficulty from its own standpoint. For the purpose of devising a generally applicable method of making short traffic counts and estimating traffic circulation, a study was begun in 1924 at the University of Wisconsin under the auspices of the Barney Link Fellowship.

A 62-page bulletin recently issued by the college of engineering of the university gives the results of six years of research and study. It contains formulas, tables, forms for recording traffic data, and much other information of value to those interested in traffic counts and their uses. Through the courtesy of the Outdoor Advertising Association, copies of this bulletin are available to Society members on request to the Association at 165 West Wacker Drive, Chicago.

Rope Friction Saves a Bridge

HAS a similar incident ever happened to you? Have you had a close call, an exciting moment in carrying out your work? From time to time, as contributors make material available, the Committee on Publications will consider brief narratives of uncommon experiences for publication in these columns.

The following account is by E. K. Morse, M. Am. Soc. C.E., of Pittsburgh, who represents District 6 as Director, and has prized his membership in the Society for thirty years. He is still active in his profession.

"In 1886, S. V. Ryland made a contract with the Union Bridge Company of New York City to erect the superstructure of the Hawkesbury Bridge in Australia, a 7-span, double-track railroad bridge 416 ft. from center to center of end pins, across the Hawkesbury River north of Sydney, New South Wales. One of the conditions was that he should make a contract with some one who would be able to go ahead and finish the erection in case of his death.

"In the spring of 1887, I made a contract with Mr. Ryland to that effect, and on March 5, 1887, I sailed from San Francisco for Sydney. We made our headquarters on Dangar Island, in the Hawkesbury River. While Mr. Ryland looked after the social side and provided the finances, my duty was to construct the plant and superintend the construction and erection of the seven spans.

"The spans were to be floated on pontoons from three to six thousand feet into position. They were to be brought to the site at high tide so that at low tide the pontoons could be floated out from under them. Each pontoon was 61 ft. wide and 335 ft. long with 44 water-tight compartments supporting a timber trestle 40 ft. high. The steelwork was delivered by ship up the Hawkesbury River to Dangar Island, where it was piled and sorted.

"Each pontoon rested on a steel grid supported by piles 2 ft. below low tide. The maximum high tide was 8 ft. 6 in. It was planned to erect each span complete on a pontoon as it rested on the grid. At low tide the valves of the 44 water-tight compartments were to be closed and at high tide the span would float out from the dock. Then by continuous rope haulage it was to be pulled into position. The hoist engines used in erecting were placed on a permanent dock at one end of the pontoon. The clear height of the erection traveler above the deck of the pontoon was 150 ft. The steelwork was run in on a single track from the dock on to the deck of the pontoon and hoisted from there to position in the span. Mr. Ryland was an expert erector, and although I was but slightly over thirty years old, I had spent years in designing and erecting bridges and in rigging and top chord connection work, and was as near an expert as they got, and a fearless, daredevil climber.

"It had taken several months longer than I had anticipated to get started and ready for the erection of the first span, so that Mr. Ryland was impatient to start erection. There was only one thing left to complete when he decided that he had to see the first top chord section erected in place at once. The one essential thing was a gang of permanent snatch blocks designed for each leg on each side of the traveler, a most vitally important factor. I wanted to wait a week before starting the erection of the first span, but finally I yielded and decided to put up the center top chords without the snatch blocks.

"The center top chord sections of this bridge were $31^1/_2$ ft. long and weighed 16 tons. The blocks, the first all steel blocks that had ever been used at that time in the erection of a bridge, were designed by me while at Chicago and they had been built at Athens, Pa. These were four- and three-sheave blocks, each sheave 16 in. in diameter, intended for $1^1/_4$-in manila rope. In order to have the pleasure of connecting up the first section, I went to the top of the traveler at the near end so that I could give signals direct to the hoisting engineers. The lead line on my end of the section led direct from the top sheave to the drum of the hoist engine, which was about 300 ft. distant.

"After hoisting the section high enough to connect to the top of the intermediate posts, the snubber on my end for some reason released his snub without orders and when I yelled to him, "check up," he checked the snub so fast that it swung the chord section into the air until the top chord plate touched the lead line. Instantly it began to part. Before I could think or realize what I was doing I had somehow jumped from the traveler platform about six feet, grabbed two hoisting lines between my two hands and let out a scream that they heard all over the island. There I was, suspended in mid-air.

"By that time I knew what I was doing and yelled to Mr. Ryland to send riggers to me, which meant sailors, as over half of our laborers were sailor jacks. Fortunately I had built wooden stairs from the deck of the pontoon to the top of the trestle, whence they zigzagged on up to the top of the traveler. While I was hanging on with a death grip the sailors rushed up, and as every jack carries a knife in one hip pocket and thrappings in the other, it was only a few minutes until every part of each line was thoroughly thrapped together.

"During all that time my mind was cool enough to give instructions as to what was to be done both in the thrapping and at the hoist engine, and in a few minutes new falls were attached to the top chord. But when it came to releasing me from my grip, I couldn't let go. The sailors were wildly excited and so was everybody else, apparently, but myself. Finally I had a snubbing rope attached to me and then the sailors pried open my hands. My grip had been so intense and had set so hard that the fingers had to be pried open. It was days before my grip got back to a normal condition.

"If I had not instantly sprung into the air, gripped those hoist lines and pressed them together, that great section would have plunged to the deck of the pontoon, and the traveler would have been wrecked. There is no question but that I would have been killed as well as about twenty or thirty others, for an examination of the hoist rope showed that one whole strand had parted; and the rope would have snapped in the fraction of a second.

"The interesting part of this, however, is not what I did, but the fact that it emphasizes how much friction can be developed by a very slight pressure. This occurrence led me in later years to realize that very often a bolt connecting two plates is worth a lot more than any rivet that has been driven, for the reason that tension can be exerted on the bolt while a rivet head cannot be safely counted on.

"I have noted, in the many years that I have spent in active erection work, that a great rigger or daredevil climber always possesses one characteristic, absolute confidence in his grip. A man that hasn't a powerful grip has no business to be off the ground in bridge erection. I never allowed a rigger who had been sick and reported back on the job to take his old place before he had been a week or two on the bull gang doing shore work, so that he had his grip back."

NEWS OF ENGINEERS

From Correspondence and Society Files

Col. Charles T. Leeds, member of the engineering firm of Quinton, Code and Hill-Leeds, and Barnard, of Los Angeles, and formerly U.S. District Engineer for the War Department, left October 22 for Ponce, Porto Rico, to report to the Porto Rican Government on a dock wall failure at that port.

Ralph Budd has been elected to the presidency of the Chicago, Burlington, and Quincy Railroad, and will take office on January 1, 1932. For the past 12 years Mr. Budd has been president of the Great Northern Railway.

W. H. Kirkbride, Engineer, Maintenance of Way and Structures, Southern Pacific Lines, has been appointed Chief Engineer of the Northwestern Pacific Railroad Company to succeed J. L. Campbell who has resigned from that position.

Carl W. Schoene, who has been a Draftsman in the Sewer Department, Division of Engineering, in Columbus, Ohio, is now Junior Assistant Engineer in the same department.

William A. King, Assistant City Engineer of Victoria, Tex., was formerly a resident of San Antonio, Tex., where he held the position of Resident Engineer for the Terrell Bartlett Engineers, Inc.

Albert P. Loriot has resigned his position with Hazen and Whipple, of New York City, where he was Assistant Engineer, to become affiliated with Fuller and Everett, of the same city.

G. H. Burnette, Assistant Chief Engineer for the Pittsburgh and Lake Erie Railroad Company, was heretofore Chief Engineer for the Monongahela Railway, in Brownsville, Pa.

C. W. Nash, until recently Construction Engineer for the Gilpin Construction Company, in Portland, Ore., is now connected with the Washington State Highway Department.

Chad F. Calhoun has resigned as Chief Engineer and General Manager of Fisher, Ross, MacDonald and Kahn, Inc., Los Angeles office, and is now working in Oakland, Calif., with the Six Companies, Inc., builders of the Hoover Dam.

Clyde E. Haager, formerly Assistant Engineer in the County Surveyor's office in Wooster, Ohio, is now Superintendent of Maintenance, in the State Highway Department of Wooster.

W. P. Creager has moved to Buffalo where he is associated with the Power Corporation of New York as Chief Engineer. He formerly was connected with the Northern New York Utilities, Inc., in Watertown, N.Y.

A. R. Losh, who has been a State Highway Engineer in the State Highway Department of Oklahoma City, has resigned to become City Manager of that city.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From October 10 to November 9, 1931

Additions to Honorary Membership

Kittredge, George Watson (M. Jan. 6, 1886; Hon. M. Oct. 5, 1931), 592 North Broadway, Yonkers, N.Y.

Mead, Daniel Webster (Assoc. M. July 1, 1891; M. Dec. 6, 1893; Hon. M. Oct. 5, 1931), Prof., Hydr. and San. Eng., Univ. of Wisconsin; Cons. Engr., State Journal Bldg., Madison, Wis.

Pegram, George Herndon (Jun. Apr. 7, 1880; M. Jan. 3, 1883; Hon. M. Oct. 5, 1931), Chf. Engr., Interborough Rapid Transit Co., and Rapid Transit Subway Constr. Co., 2545 Seventh Ave., New York, N.Y.

Ricketts, Palmer Chamberlaine (Affiliate Feb. 3, 1886; M. Oct. 5, 1887; Hon. M. Oct. 5, 1931), President and Prof. of Mechanics, Rensselaer Polytechnic Inst., Troy, N.Y.

Additions to Membership

Allen, Mark Lawrence (Jun. '31), Care, U.S. Engr. Office, Marietta, Ohio.

Archibald, Raymond (Assoc. M. '31), Asst. Bridge Engr., State Highway Comm., Little Rock (Res., 1616 Gum St., North Little Rock), Ark.

Armstrong, Francis Wallis, Jr. (Jun. '31), Charter Club, Princeton, N.J.

Barber, Ivan Wilmot (Assoc. M. '31), Testing Engr., Western Laboratories, 1832 Jefferson Ave., Lincoln, Nebr.

Belladonna, Edmond Leo (Jun. '31), Care, U.S. Engr. Office, Marmet, W.Va.

Berry, Fredrick Martin (Assoc. M. '31), Engr., Stone & Webster Eng. Corp., Box 841, Wenatchee, Wash.

Bieber, John August (Jun. '31), Care, Surface Combustion Corp., 2375 Dorr St., Toledo, Ohio.

Bliss, Tulla Ethan (M. '31), Div. Engr., St. L.S.F.Ry., 2228 Irwin Ave., Fort Worth, Tex.

Blomgren, Arthur Charles (Assoc. M. '31), Director of Aeronautics, State of Idaho, Box 2091, Boise, Idaho.

Brewer, Monroe Frank (Jun. '31), 5049 Page Boulevard, St. Louis, Mo.

Brown, Charles Calvin (Jun. '31), Field Engr., New York Steam Corp., 280 Madison Ave., New York (Res., 35-20 Leavitt St., Flushing), N.Y.

Caiola, Fred (Assoc. M. '31), Mgr., New York Cast Stone Corp., 1219 Oak Point Ave. (Res., 2840 Wellman Ave.), New York, N.Y.

Carson, Verner Eugene (Jun. '31), 872 Iowa St., Ashland, Ore.

Cawood, Keith Crews (Jun. '31), Project Engr., State Highway Comm., State House Annex, Indianapolis, Ind.

Close, Ross Arthur (Jun. '31), 60 West Ave., Wellsboro, Pa.

Cowen, Chester Melcenia (Jun. Oct. '31), 416 Minnesota Ave., Chickasha, Okla.

Creasy Donald Crampton (Jun. '31), 1281 Madison Ave., New York, N.Y.

Curtis, Ira Nankervis (Jun. '31), Insp., U.S. Engr. Office, 2112 East Park Pl., Milwaukee, Wis.

Dawson, John Robert (Jun. '31), Junior Structural Engr., National Advisory Committee for Aeronautics, Route 3, Box 293, Hampton, Va.

Didden, Clement Albert (Jun. '31), 139 Twelfth St., S.E., Washington, D.C.

Ducharme, Jean Marc (Jun. '31), Rouses Point, N.Y.

Duddleston, Morris Theodore (Jun. '31), Res. Engr., Continental Constr. Corp., Box 343, Beatrice, Nebr.

Durr, Charles Eugene, Jr. (Jun. '31), 1989 Morris Ave., New York, N.Y.

Dwyer, Eugene Michael (Assoc. M '31), 300 West 12th St., New York, N.Y.

Ellis, Edison William (Jun. '31), Alger, Ohio.

Erthal, Karl Emil (Jun. '31), 3923 Ridgewood Ave., Baltimore, Md.

Ettlinger, William DeRoy (Jun. '31), 500 West End Ave., New York, N.Y.

Ewing, Charles Russell (Jun. '31), Care, State Dept. of Public Works, Div. of Highways, Poughkeepsie, N.Y.

Farquhar, Frank Shaw (Jun. '31), 59 Park Ave., Winthrop, Mass.

Feinberg, Abraham (Jun. '31), 622 Stone Ave., Brooklyn, N.Y.

Felker, Franklin Mechtley (Jun. '31), 121 Pannebaker Ave., Lewistown, Pa.

Fertik, Joseph (Assoc. M. '31), Squad Leader and Checker, Elec. Bond & Share Co., 2 Rector St., New York (Res., 1547 Sixty-Fourth St., Brooklyn), N.Y.

Five, Helge (Assoc. M. '31), Park Engr. (Design), Long Island State Park Comm. (Res. 49 Mason Ave.), Babylon, N.Y.

Foster, Francis Xavier (Jun. '31), 2659 Bainbridge Ave., New York, N.Y.

Friedland, Jacob (M. '31). Asst. Engr., with President Borough of Manhattan, Municipal Bldg. (Res., 2807 Claflin Ave.), New York, N.Y.

Gebhard, Jerome Peter (Assoc. M. '31), Secy. and Mgr., A. C. Guetzkow, Inc., 5420 West State St., Milwaukee, Wis.

Gessner, Edward Heim (Jun. '31), 119 Audubon Boulevard, New Orleans, La.

Gevecker, Vernon Arthur Charles (Jun. '31), 5036 Maffitt Ave., St. Louis, Mo.

Ghiglione, Angelo Francesco (Jun. '31), 21 Falmouth St., Belmont, Mass.

Gibson, Edwin Emmons (Jun. '31), 113 Ashley Ave., Charleston, S.C.

Grady, John Francis (Assoc. M. '31), Div. Engr., State Highway Comm. (Res., 607 South Evergreen), Chanute, Kans.

Graham, Harry Edward (Jun. '31), 156 Third Ave., Phoenixville, Pa.

Haberer, John Charles (Jun. '31), 125 Addington Pl., Utica, N.Y.

Hammack, James Albert, Jr. (Jun. '31), 403 College Ave., Ithaca, N.Y.

Hardy, George Henry (Jun. '31), 39-55 Fifty-Fifth St., Woodside, N.Y.

Harrell, Charles Adair (Assoc. M. '31), City Mgr., City Hall, Portsmouth, Ohio.

Harrison, Edgar Scruggs (Jun. '31), Care, The Tennessee Elec. Power Co., Chattanooga, Tenn.

Hartung, Luther Haverkost (Jun. '31), 262 Cottage Ave., Tamaqua, Pa.

Haskell, Nelson Burritt (Jun. '31), D-33 McCulloch, Soldiers Field, Boston, Mass.

Haufler, Herbert Andrew (Assoc. M. '31), Asst. Engr., Essex County Eng. Dept., 123 Fourth St., Newark, N.J.

Hayden, Thomas Jefferson, Jr. (Jun. '31), Box 328, Canton, N.C.

Henderlite, Harry Benjamin (M. '31), State Highway Engr., State Highway Comm., Baton Rouge, La.

HILL, ALBERT EDWARD (Jun. '31), 5951 West Huron St., Chicago, Ill.

HIRTLE, EUGENE GERRERD (Jun. '31), Instr., Gen. Eng., Univ. of Washington, 305 Education Hall, Univ. of Washington, Seattle, Wash.

HOGAN, BEN MILES (Assoc. M. '31), Paving Contr. (Hogan Constr. Co.) (Res., 5323 Edgewood Ave.), Little Rock, Ark.

HOGAN, JOHN IGNATIUS LOYOLA (M. '31), Chf. Engr., Triest Contr. Corp., New York (Res., 54 Seventy-Seventh St., Brooklyn), N.Y.

HOLLENBECK, LEO EDWARD (Jun. '31), 1711 North Jefferson Ave., St. Louis, Mo.

HOUSHOLDER, VIC. H. (Assoc. M. '31), Sales Engr., California Corrugated Culvert Co., 1330 East Brill St., Phoenix, Ariz.

HOUSTON, ROBERT LOCHARD (Jun. '31), 338 North 1st Ave., Tucson, Ariz.

HUGILL, HARRY STANLEY (Jun. '31), Route 1, Hubbard, Ore.

HURLBUTT, ROBERT HAMILTON (Jun. '31), 416 North West 6th Ave., Galva, Ill.

IVERS, WILLIAM JOSEPH (Jun. '31), 6220 Prentice St., Cincinnati, Ohio.

JELLEY, JOSEPH FRANKLIN, JR. (Jun. '31), Lieut. (jg), C.E.C., U.S.N.; 1991 Fifteenth St., Troy, N.Y.

JOHNSON, WENDELL EUGENE (Jun. '31), Office Man, State Highway Dept., 208 West Oakland Ave., Austin, Minn.

JONES, RALPH KELLY (Jun. '31), with State Highway Dept. (Res., 623 Cascade Ave., S.W.), Atlanta, Ga.

JORDAN, ALBERT FREDERICK (Assoc. M. '31), Cost Estimator, McClintic-Marshall Corp. (Res., 1621 Cloverleaf St.), Bethlehem, Pa.

JOSLIN, JOHN GRANT (Jun. '31), Care, U.S. Engr. Office, Huntington, W.Va.

KEESEE, GERALD BRUCE (Assoc. M. '31), Prin. Asst. Engr., Brown County Water Impvt. Dist. 1, Box 118, Brownwood, Tex.

KELLER, FRANK MARION (Assoc. M. '31), care, U.S. Bureau of Public Roads, Denver, Colo.

KERR, GEORGE WATSON (Jun. '31), Asst. Materials Engr., State Div. of Highways, 307 Trust Bldg., Newark, Ohio.

KIDD, JEFFERSON ERNEST (Assoc. M. '31), Res. Engr., Bridge Dept., State Highway Comm., Box 956, Alexandria, La.

KIMBROUGH, CLYDE WILLIAM (Jun. '31), Asst. Engr., Dept. of Public Utilities, City of Tacoma, Camp B, Potlatch, Wash.

KOVACICH, STEPHEN (Jun. '31), 609 McClellan St., Lead, S.Dak.

KRAUS, JOHN HENRY (Jun. '31), 84-52 Grand Ave., Elmhurst, N.Y.

LAPPA, GEORGE PAUL (Jun. '31), Draftsman, Auditor's Office, Hamilton County (Res., 807 Cleveland Ave.), Cincinnati, Ohio.

LEHLBACH, ARNOLD MILTON (Jun. '31), 115 Florence Ave., Irvington, N.J.

LEWIS, SIDNEY FRANCIS, III (Jun. '31), 1229 North Rampart St., New Orleans, La.

LOUTZENHEISER, DONALD WILSON (Jun. '31), Care, Div. of Management, Bureau of Public Roads, Washington, D.C.

MACFARLAND, LESTER BURTON (Jun. '31), 25 Perley St., Lebanon, N.H.

MCDONALD, CHARLES CASTO (Jun. '31), Junior Hydr. Engr., U.S. Geological Survey, Marble Canyon, Ariz.

MALTSEFF, MICHAEL NICKOLAS (Assoc. M. '31), Designer-Draftsman, Western Pipe & Steel Co. (Res., 131 Hugo St.), San Francisco, Calif.

MASONI, JOHN GABRIEL (Jun. '31), Constr. Engr., Lowensohn Constr. Co. (Res., 15200 Lydian Ave.), Cleveland, Ohio.

MEYER, HAROLD (Jun. '31), Concrete Insp., Brooklyn Edison Co. (Res., 1213 Seventy-Eighth St.), Brooklyn, N.Y.

MEYER, OTTO HERMAN (Jun. '31), Insp., U.S. Engr. Dept., Box 237, Columbia, Mo.

MILLER, HAROLD EUGENE (Jun. '31), Junior Engr., U.S. Reclamation Service, 929 Pearl St., Denver, Colo.

MOINICHEN, JOHAN LUDVIG (Assoc. M. '31), Draftsman, Cincinnati Union Terminal Co., 1020 Temple Bar Bldg., Cincinnati, Ohio.

MONTANARI, IVO LOUIS (Jun. '31), R.D.1, Box 162, Ridgefield, Conn.

NORTON, ROBERT ASHMALL (Jun. '31), 167 North Whittlesey Ave., Wallingford, Conn.

O'CONNOR, THOMAS JOSEPH (Assoc. M. '31), Asst. Engr., Elec. Bond & Share Co., Esmeralda 188, Buenos Aires, Argentine Republic.

ORBANOWSKI, HORST HANS (Jun. '31), 35 Bay View St., Quincy, Mass.

PACCAGNELLA, CHARLES PAUL (Jun. '31), 345 Hanover St., San Francisco, Calif.

PARKER, CHARLES VICTOR (Jun. '31), Box 1, Phoenixville, Pa.

PATTERSON, ROBERT SHEPHERD (Jun. '31), Project Engr., Stayton & Veatch, 508 Interstate Bldg., Kansas City, Mo.

PFAU, RALPH LESLIE (Assoc. M. '31), Chf. of Party, U.S. Coast and Geodetic Survey, Washington, D.C.

PILLSBURY, CHARLES STEPHEN (M. '31), with Chicago Bridge & Iron Works (Res., 10415 South Seeley Ave.), Chicago, Ill.

PORTER, EARL LEONARD FRANKLIN (Jun. '31), Draftsman, State Highway Dept., Y.M.C.A., Duluth, Minn.

PROUD, ERNEST LEROY (Jun. '31), Draftsman, Met. Dist. Water Supply Comm., 20 Somerset St., Boston, Mass.

RAITER, CLIFFORD RAYMOND (Assoc. M. '31), Engr., Northern States Contr. Co., 312 Endicott Bldg. (Res., 1661 Hillcrest Ave.), St. Paul, Minn.

RANDIO, WESLEY HERBERT (Jun. '31), Lieut. (jg), C.E.C., U.S.N., 1441 Mallory Court, Norfolk, Va.

RISHELL, CHARLES GERALD (Jun. '31), 204 East 4th St., Emporium, Pa.

ROBERTI, LOUIS E. J. (Jun. '31), 847 East 218th St., New York, N.Y.

ROBINSON, HARLAN BAIRD (Jun. '31), 346 Palmetto Drive, Pasadena, Calif.

ROBERTS, CYRUS MARION (Assoc. M. '31), 1st Asst. City Engr., Bureau of Eng. (Res., 1527 East Gibson St.), Scranton, Pa.

ROSE EDWIN (Jun. '31), 1240 Delta Ave., Cincinnati, Ohio.

SAWYER, ROBERT WILLIAM, JR. (Jun. '31), Care, Malcolm Pirnie, 25 West 43d St., New York, N.Y.

SCHMID, ALBERT DARWIN (Assoc. M. '31), Asst. Office Engr., State Highway Dept. (3105 University Drive), Fort Worth, Tex.

SMITH, RUSSELL LINCOLN (Jun. '31), 478 Munich St., San Francisco, Calif.

STANLEY, HOWARD BURTON (Jun. '31), 2601 Forty-Ninth St. S.E., Portland, Ore.

STEINBACH, CHARLES WILLIAM (Jun. '31), Mass. Inst. Tech. Dormitories, Cambridge, Mass.

STERN, CHARLES GEORGE (Jun. '31), 987 Park Ave., Union City, N.J.

STEVES, BERT FRANCIS (Jun. '31), Designer, Black & Veatch (Res., 3714 East 9th St.), Kansas City, Mo.

STUMPF, EDWARD HEER (Assoc. M. '31), Dist. Engr., National Paving Brick Assoc., Eastern Region (Res., 1439 Cliffview Rd., N.S.), Pittsburgh, Pa.

SULLIVAN, JACOB BUTLER (M. '31), Asst. Engr. and Chf. Draftsman, Cincinnati Union Terminal Co., 1020 Temple Bar Bldg., Cincinnati, Ohio.

TAYLOR, GEORGE HOLMES (Assoc. M. '31), Care U.S. Geological Survey, 313 Federal Bldg., Salt Lake City, Utah.

TERRY, FRANCIS HALLOCK (Jun. '31), Asst. Engr., Suffolk County, 38 Park Ave., Bay Shore, N.Y.

THOMAS, MENDALL PATTERSON (Jun. '31), 65 Penfield St., Roslindale, Mass.

THOMAS, PAUL GIBSON (Jun. '31), 1991 North 63d St., Philadelphia, Pa.

TOOMEY, THOMAS JEREMIAH, JR. (Jun. '31), Topographical Draftsman, Borough President's Office, Bureau of Highways (Res., 2477 Ocean Ave.), Brooklyn, N.Y.

TRUDEAU, JAMES ARTHUR (M. '31), with Shell Oil Co., Los Angeles (Res., 915 Raleigh St., Glendale), Calif.

VICENTE, ELISIO FERREIRA (Jun. '31), 1900 Grand Concourse, New York, N.Y.

WAGENER, FREDERICK WILLIAM (Jun. '31), Junior Hydr. Engr., U.S. Geological Survey, 801 Loan & Exchange Bldg., Columbia, S.C.

WALDBILLIG, GERALD WILLIAM (Jun. '31), President, John B. Waldbillig, Inc., 400 Second St., Albany, N.Y.

WARE, WALTER JUSTUS (Jun. '31), Junior Engr., U.S. Engr. Office, 609 Postal Telegraph Bldg., Kansas City, Mo.

WATSTEIN, DAVID (Jun. Oct. '31), Junior Structural Engr., U.S. Bureau of Standards (Res., 3221 Mt. Pleasant St., N.W.), Washington, D.C.

WATTERS, HENRY BERTRAM (M. '31), President, The H. B. Watters Co., 8 East Long St., Columbus, Ohio.

WATTS, ROLAND STUART (Assoc. M. '31), Res. Engr., F. A. Barbour, Boston (Res., 444 Washington St., Braintree), Mass.

WEINSTEIN, HENRY (Jun. '31), Draftsman and Computer, State Highway Comm., Box 223, Rock Springs, Wyo.

WEINSTEIN, HOWARD (Jun. '31), 23 Earle St., Hartford, Conn.

WEISS, FREDERICK MARTIN (Jun. '31), 205 Foulke Hall, Princeton, N.J.

WILEY, TARLEY TARSON (Jun. '31), 630 East Van Buren, Ottawa, Ill.

WILKES, EDMUND, JR. (M. '31)., Chf. Structural Engr., Jones-Hettelsater Const. Co., 600 Mutual Bldg., Kansas City, Mo.

WILL, CHARLES CHRISTIAN (Jun. '31), 2431 Montgomery St., Louisville, Ky.

WILLIAMS, HERBERT LESTER (Assoc. M. '31), Associate and Civ. Engr., U.S. Engr. Dept., 4400 Dauphine St., New Orleans, La.

WINSTON, HERBERT OWEN (Jun. '31), Box 45, West Orange, N.J.

WOODS, ROBERT JAMES, JR. (Jun. '31), Office Engr., W. C. Caye & Co., 160 Walker St., Atlanta, Ga.

WOOLLEY, FRED (Jun. '31), Manti, Utah.

WRIGHT, GEORGE CREIGHTON (M. '31), County Supt. of Highways Monroe County, 1609 Culver Rd., Rochester, N.Y.

YELM, CHARLES WALTER (M. '31), Associate Engr., Waddell & Hardesty, 150 Broadway, New York, N.Y.

MEMBERSHIP TRANSFERS

ALLAN, WILLIAM (Jun. '24; Assoc. M. '31), 30-91 Forty-Second St., Long Island City, N.Y.

BABCOCK, JOHN BRAZER, 3d. (Assoc. M. '23; M. '31), Prof., Railway Eng., Mass. Inst. Tech., Room 1-337, Mass. Inst. Tech. Cambridge, Mass.

BAKER, SAMUEL (Assoc. M. '27; M. '31), Director Civ. Eng. Schools, International Correspondence Schools (Res., 1004 Monroe Ave.), Scranton, Pa.

BANTA, ARTHUR PERRY (Jun. '27; Assoc. M. '31), Asst. Engr., Los Angeles County Sanitation Dists., 202 Law Bldg., Los Angeles (Res., 681 South Oakland Ave., Pasadena), Calif.

BONINI, FRANCIS JOSEPH (Jun. '25; Assoc. M. '31), Junior Asst. Engr., Grade 2, State Div. of Highways, 116 Main St., Babylon (Res., 6 Madison St., Mount Vernon), N.Y.

BROOMALL, CAROLUS MORTON (Assoc. M. '20; M. '31), Borough Engr. of Swarthmore, Borough Engr. (Res., 341 East State St.), Media, Pa.

BURNS, THOMAS MORRIS (Affiliate '28; Assoc. M. '31), Executive Engr., East Jersey Pipe Co., 7 Dey St. (Res., 26 East 10th St.), New York, N.Y.

CASSIL, ARMOND (Jun. '26; Assoc. M. '31), President, Armond Cassil, Inc., 5-107 Gen. Motors Bldg., Detroit, Mich.

CATES, WALTER HERBERT (Jun. '27; Assoc. M. '31), Hydr. and Sales Engr., Western Pipe & Steel Co. of California, 5717 Santa Fe Ave. (Res., 1428 Holbrook St.), Los Angeles, Calif.

CHRISTENSON, ELMER JOHN (Jun. '29; Assoc. M. '31), Junior Engr., U.S. Engr. Office, Alma, Wis.

COLLINS, HARRY JOSEPH (Jun. '28; Assoc. M. '31), 1924 Park Ave., Dallas, Tex.

DAVIS, BERRIEN WALKER (Assoc. M. '23; M. '31), County Engr., Nash County, Nashville (Res., 841 Sunset Ave., Rocky Mount), N.C.

DERBY, ELLES MAYO (Jun. '28; Assoc. M. '31), Designer and Detailer, N.Y.C.R.R., 466 Lexington Ave., New York, (Res., 1773 East 13th St., Brooklyn), N.Y.

Doebler, Horatio Ward (Jun. '25; Assoc. M. '31), Supt., L. Kalischer, Inc., 288 Livingston St. (Res., 1758 Brooklyn Ave.), Brooklyn, N.Y.

Dow, Peter Staub (Assoc. M. '18; M. '31), Prof. and Chairman, Dept. of Graphics and Eng., Dartmouth Coll., Box 83, Hanover, N.H.

Emmett, William Edwin (Assoc. M. '28; M. '31), Dist. Engr., Am. Inst. of Steel Constr., Inc., 348 San Carlos Ave., Piedmont, Calif.

English, Henry William (Jun. '13; Assoc. M. '18; M. '31), 4205 Holland Ave., Dallas, Tex.

Farrell, Kingston Allen (Assoc. M. '26; M. '31), Engr. (Jensen, Bowen & Farrell), Ann Arbor, Mich.

Ferris, Charles Birdsall (Jun. '28; Assoc. M. '31),) Gen. Contr. (Westchester Builders), 758 North Broadway, Yonkers, N.Y.

Gillham, Philip Dakin (Jun. '06; Assoc. M. '11; M. '31), with State Highway Dept. (Res., 320 Steele St.), Frankfort, Ky.

Gronquist, Carl Harry (Jun. '27; Assoc. M. '31), Res. Engr., Robinson & Steinman, Box 259, Bucksport, Me.

Hardesty, James Marion (Jun. '24; Assoc. M. '31), Member of Technical Staff, Bell Telephone Laboratories, Inc., 463 West St., New York, N.Y.

Hinman, Jack Jones, Jr. (Assoc. M. '29; M. '31), Associate Prof. of Sanitation, and Chf., Water Laboratory Div., State Hygienic Laboratories, Univ. of Iowa (Res., 121 Melrose Ave.), Iowa City, Iowa.

Holley, Harold Fiske (Jun. '15; Assoc. M. '18; M. '31), Asst. Chf. Engr., Automobile Club of Southern California, 2601 South Figueroa St., Los Angeles, Calif.

Holt, Andrew Hall (Jun. '13; Assoc. M. '20; M. '31). Associate Prof., Civ. Eng., Coll. of Eng., State Univ. of Iowa, Eng. Bldg., State Univ. of Iowa, Iowa City; Iowa

Hughes, Conrad Percy (Jun. '30; Assoc. M. '31), 423 Cedar St., Sault Ste. Marie, Mich.

Jemison, Lawrence Lee (Assoc. M. '22; M. '31), Bridge Engr., State Road Comm., 21 Curry St., South Charleston, W.Va.

Kelcey, George Guy (Assoc. M. '25; M. Oct. '31). Mgr., Traffic Eng. Div., Am. Gas Accumulator Co. (Res., 844 Cross Ave.), Elizabeth, N.J.

Labarre, Robert V. (Assoc. M. '20; M. '31), Cons. Engr., 1151 South Broadway, Los Angeles, Calif.

Learned, Clyde Emerson (Assoc. M. '15; M. '31), Asst. to Dist. Engr., U.S. Bureau of Public Roads (Res., 988 South Williams St.), Denver, Colo.

Lent, Richard Perkins (Assoc. M. '23; M. '31). Asst. Engr., Long Island State Park Comm., 5 South Clinton Ave., Bay Shore, N.Y.

Olson, Howard Oscar (Jun. '26; Assoc. M. '31), Engr., Franklin Limestone Co., 612 Tenth Ave., North, Nashville, Tenn.

Peckworth, Howard Faron (Jun. '27; Assoc. M. '31), with Slattery-Daino Co., Inc., 169 Kingston Ave., Brooklyn, N.Y.

Robinson, John Edward (Jun. '26; Assoc. M. '31), Designer and Estimator, Am. Bridge Co., 30 Church St., New York (Res., 954 East 32d St., Brooklyn), N.Y.

Rockett, Louis Charles (Assoc. M. '24; M. '31), Engr., U.S. Bureau of Public Roads, Santa Fe, N.Mex.

Ross, Marion Drake (Assoc. M. '28; M. '31), Dist. Engr., State Highway Dept., 712 Coppin Bldg., Covington, Ky.

Schuyler, Walter Wesley (Jun. '14; Assoc. M. '19; M. '31), Gen. Mgr., Cuban Divs., United Fruit Co., Preston, Oriente, Cuba.

Seymour, Edwin Newburger (Jun. '19; Assoc. M. '20; M. '31), Office Engr., State Highway Board, Atlanta, Ga.

Shaw, Clark Hervey (Assoc. M. '15; M. '31), Chf. Engr., Water Dept. (Res., 236 East 10th St.), Long Beach, Calif.

Smedberg, Carl Waldemar (Assoc. M. '21; M. '31), Director, Public Works and Service (Res., 315 Woodbine Court), Greensboro, N.C.

Stabell, Frederick Philip (Assoc. M. '18; M. '31), Vice-Pres. and Secy., The Samuel W. Hoyt, Jr. Co., Inc., 5 Railroad Ave., South Norwalk, Conn.

Stapley, Edward Ray (Assoc. M. '26; M. '31), Associate Prof., Civ. Eng., Oklahoma Agri. and Mech. Coll. (Res., 27 College Circle), Stillwater, Okla.

Studdert, William Walton (Jun. '30; Assoc. M. Oct. '31), Chf. Insp., State Dept. of Highways, Trust Co. Bldg., Franklin, Pa.

TOTAL MEMBERSHIP AS OF NOVEMBER 9, 1931

Members	5,900
Associate Members	6,337
Corporate Members	12,237
Honorary Members	16
Juniors	2,700
Affiliates	127
Fellows	5
Total	15,085

Trapp, Arthur John (Jun. '28; Assoc. M. '31), Asst. Engr.-Foreman, Dept. of Commerce, Lighthouse Service, 1st Dist., Care, Supt. of Lighthouses, Portland, Me.

Vail, John Jervis (Assoc. M. '05; M. '31), Engr. of Constr., P.R.R.; 148 Commerce St., Rahway, N.J.

Weinman, Irving Martin (Jun. '27; Assoc. M. '31), Asst. to Chf. Engr., Thompson, Leopold, Fredburn Eng. Co., 60 East 42d St. (Res., 617 West 141st St.), New York, N.Y.

White, Herbert LeRoy (Jun. '26; Assoc. M. '31), Asst. Engr., State Water Survey, 6 Tuscan Court, Urbana, Ill.

Willard, Ernest Clifford (Assoc. M. '15; M. '31), Cons. Engr., 720 Corbett Bldg., Portland, Ore.

Reinstatements

Greenfield, Robert Arthur, M., reinstated Oct. 4, '10.

Resignations

Hicks, Richard Joseph, Assoc. M., resigned Oct. 29, '31.

MacKrell, Edwin Allan, Assoc. M., resigned Oct. 20, '31.

Mukasa, Shitaro, M., resigned Oct. 13, '31.

Rowe, Norman Leslie, 3d, Jun., resigned Nov. 6, '31.

Deaths

Carson, Howard Adams. Elected M., Feb. 7, 1894, Hon. M., Oct. 10, 1921; died Oct. 26, 1931.

Comly, James Retzer. Elected Assoc. M., Apr. 2, 1913, M., Oct. 11, 1920; died Oct. 6, 1931.

Drake, Robert Morris. Elected Assoc. M., Mar. 7, 1900; died Oct. 25, 1931.

Hodge, Harry Seymour. Elected M., Oct. 3, 1894; died Nov. 21, 1929.

Kehoe, Alfred Lawrence. Elected Assoc. M., Sept. 10, 1918, M., June 16, 1924; died Oct. 17, 1931.

Landreth, Olin Henry. Elected M., Sept. 3, 1884; died Nov. 5, 1931.

Lawson, Elmer Barthold. Elected Jun., Nov. 14, 1927; died Oct. 8, 1931.

Lawton, William Henry. Elected M., June 2, 1886; died Nov. 4, 1931.

Odell, Frederick Sylvester. Elected M., Mar. 5, 1884; died Oct. 20, 1931.

Riser, Knud Sophus. Elected M., Feb. 3, 1892; died Nov. 1, 1931.

Sengoku, Mitsuou. Elected M., June 4, 1890; died Oct. 30, 1931.

Men and Positions Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 97 of the 1931 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

Men Available

Civil Engineer; Assoc. M. Am. Soc. C.E.; 30; married; graduate, Massachusetts Institute of Technology; 5 years field and office experience with large engineering corporation; qualified to design and erect steel, reinforced concrete, or timber structures. Salary desired, $275 a month. Location immaterial. C-1566.

Civil Engineer; Assoc. M. Am. Soc. C.E.; over 20 years well-rounded experience—field work covering surveys, location, and construction, and office work on drafting, design, and estimating. Former engagements principally on city water work, railroad, and industrial and hydro-electric plants. Thorough, practical, and of highest integrity. B-5199.

Structural Engineer; M. Am. Soc. C.E.; 44; married. Has been in charge of all departments structural steel fabricating business in Pittsburgh and Cleveland districts. Desires connection with progressive concern to direct estimating, designing, and pricing—can also handle sales. Available immediately. C-5095.

Graduate Engineer; Jun. Am. Soc. C.E.; 27; single; 6 months timekeeper and supply clerk on reinforced concrete drain; 2 1/2 years tool, machine, aeronautical, and structural design; 6 months transport survey work; 4 months engineering and designing on electric traction type and hydraulic elevators. Location and salary open. C-9468.

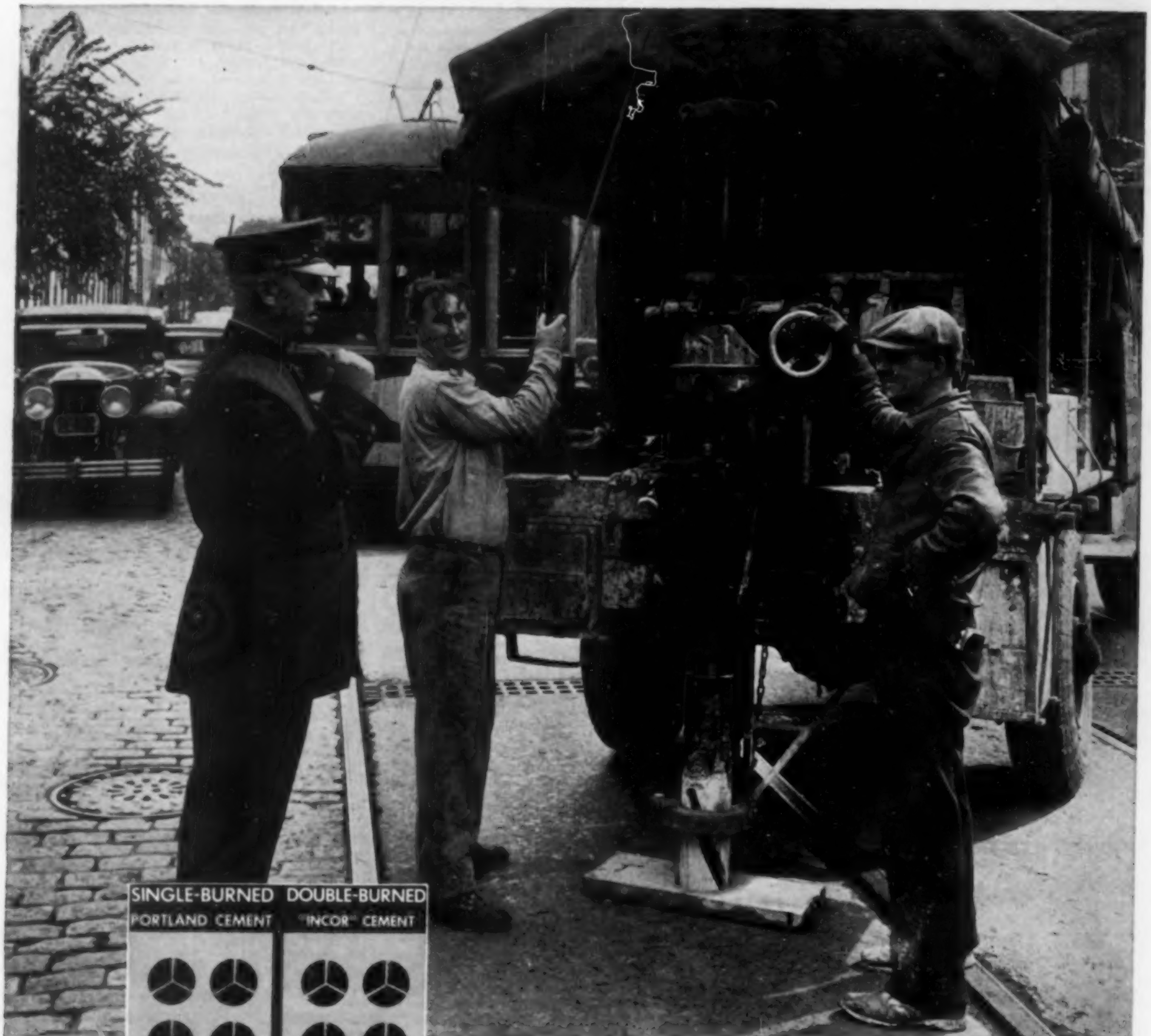
Office or Valuation Engineer; Assoc. M. Am. Soc. C.E.; 30 years experience, domestic and foreign—10 years design and construction, bridges, subaqueous tunnels, and concrete structures; 8 years field investigations, estimates, and reports on existing structures and new work; 4 years valuation, bridges, subways, water works; 8 years building construction, estimates, office engineer. B-5455.

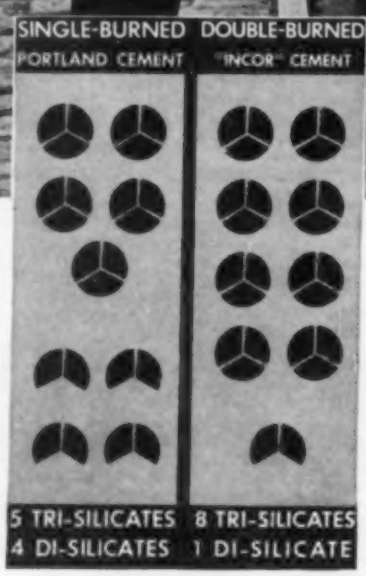
Sanitary Engineer; Assoc. M. Am. Soc. C.E.; graduate, Cornell University. Thoroughly experienced in sewerage and water-works design; last 3 1/2 years at work entirely at drafting table for leading sanitary engineers; 3 years outside sanitary work; 5 years building design and construction. At present in responsible charge of design. C-6422.

Civil and Structural Engineer; Assoc. M. Am. Soc. C.E.; licensed professional engineer; 2 years highway construction, surveying, and inspection; 13 years structural steel designing and detailing of office, residential, industrial, and theater buildings. Especially expert on theater work. Immediately available. New York or vicinity preferred, but will consider any location. B-4202.

Graduate Civil Engineer; Jun. Am. Soc. C.E.; 5 years varied structural experience detailing, checking, designing, and inspecting all types of structures; 3 years with one of largest fabricators; 2 years with consulting engineers.

"You'll have to get





"YOU CAN'T BLOCK TRAFFIC THIS WAY." A re-enactment of the Albany scene described on the opposite page, in which a driller, tackling his first 'Incor' core, had his calculations upset and tied up Clinton Avenue traffic for half an hour.

WHY 'INCOR' IS TOUGH. (Left) The diagram serves to illustrate the difference in chemical constitution between ordinary Portland Cement and 'Incor' Portland Cement. The complete circles symbolize molecules of *tri*-calcium silicate which are active and combine easily and thoroughly with water. The incomplete circles symbolize molecules of *di*-calcium silicate which are sluggish and combine slowly. This difference in refinement, which insures extremely high *early*-and *ultimate* strength, is achieved by double burning.

the rest of those after the street cars *stop*"

IT all began as an experiment, and ended—or nearly ended—with a summons . . .

Back in 1927 the United Traction Company of Albany, New York, was laying sections of concrete pavement within their track areas.

Their engineers had heard of 'Incor,' had investigated it, and decided to try it on one of their special jobs—a cross-over on Clinton Avenue—where concrete had to be laid without interrupting traffic.

The 'Incor' concrete was duly laid. Adjoining it, as a comparative test, a section of ordinary Portland cement was laid, to which had been added, to promote rapid hardening, 8 pounds per bag of a commercial "accelerator."

In 24 hours the 'Incor' pavement was opened to traffic. Despite the accelerator, the adjoining section of concrete was held for another full day.

4 Years Pass

As time went by the fine condition of the 'Incor' pavement attracted notice, and the question of strength came up. It was decided to drill cores from the pavement and determine exactly what the ultimate strength might be.

On June 1, 1931, a driller called on the Traction Superintendent for permission.

"You want to drill cores, eh, on Clinton at the Robin Street Cross-over. How big?"

"Four inch."

"How long will they take you?"

"About 6½ minutes apiece."

"All right. Go out at 10 and get them between cars."

The driller manned his truck, drove to the crossing, waited till Belt Line No. 3 passed, and immediately began drilling 'INCOR' CORE No. 1. He felt easy. He had 7 minutes before the next car was due.

He didn't feel easy long.

Fourteen minutes passed, two street cars were tied up, a motorman was glaring at him—and he wasn't half-way through the first core.

He added water to the drill, increased the pressure, and cursed the concrete.

Twenty minutes later he was still at it. Five street cars were lined up, traffic was blocked, three motormen were trying to help him and a passenger had gone for a policeman—who soon appeared.

"What are you doing?"

"Drilling cores."

"Where's your permit?"

"Here."

7200 POUNDS PER SQUARE INCH. Compression machine and broken specimen. The five 4-year old 'Incor' cores drilled from the Robin Street cross-over in Albany, New York, developed an average compressive strength of 7200 pounds per square inch.

"How long will you take?"

"I'm just about done with this one."

"How many more do you want?"

"Four."

"*Four!* You can't block traffic this way. You'll have to get the rest of those after midnight, when the street cars stop."

Which is exactly what he did—working from 2 A. M. till dawn.

The toughness of this concrete was something new in a driller's experience—a fact amply borne out in the ultimate strength tests next day.

These five 'Incor'* cores, 4 years old, developed an average ultimate strength of 7200 pounds per square inch.

Cores drilled from the adjoining ordinary Portland cement special-mix concrete pavement, at the same age, developed a strength of 4343 pounds per square inch—a good strength—but 2800 pounds per square inch less than that of the 'Incor' concrete.

The extremely high *early*-and-*ultimate* strengths of 'Incor' cement are understandable when it is remembered that they are both achieved, not through the use of an admixture or an increased proportion of cement, but by means of the double-burning process which assures that every particle of the entire lot is of the same high quality.

*Reg. U. S. Pat. Off.

'INCOR' 24-*Hour Cement*

MANUFACTURED BY THE "DOUBLE BURNING" PROCESS

'INCOR' Cement is made by the producers of Lone Star Cement, under basic patents owned by International Cement Corporation, New York City

Desires permanent position with engineering or construction firm. Location immaterial. C-2918.

HYDRAULIC ENGINEER; M. Am. Soc. C.E.; married; university graduate; 15 years experience, largely hydro-electric developments. In charge numerous preliminary investigations, large projects—domestic and foreign, including surveys, river discharge gagings and studies, subsurface investigations, power output estimates, cost estimates, and complete reports. Also experienced in design and construction. Available immediately. Location secondary. C-9694.

DRAFTSMAN; 25; desires employment along structural steel lines; 5 years experience on tracings and drawings of a structural nature. Has worked on plans involving subway and power plant structural steelwork. Can estimate steel quantities and has knowledge of structural steel design. C-9972.

CIVIL ENGINEER; Jun. M. Am. Soc. C.E.; 23; single; graduate, Dartmouth College—A.B., 1929 and C.E., 1930; 1 summer surveying; 1½ years structural detailing; desires work on construction, drafting, or surveying. Available at once. References on request. C-9997.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; married; recent graduate, Worcester Polytechnic Institute; 2 years experience timekeeping on concrete bridge substructure work; 1 year bridgeman's helper for two largest steel erectors; also experience in erection of toolhouse of latter. Desires work, preferably in construction. Available immediately. Location, immaterial. C-9800.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 28; single; 8 years varied experience. Last 4 years on research and general engineering work for architect. Experience covers general surveying; bridge, grain elevator, and pier construction; soundings; reports; inspection; drafting; and design and layout of park. Excellent references. Available immediately. Location immaterial. D-7.

STRUCTURAL AND SALES ENGINEER; Assoc. M. Am. Soc. C.E.; 38; married; university graduate; 12 years experience in sales and sales management, design, detail, and estimating of all steel requirements for bridges and buildings. Available immediately. Capable and forceful. Location immaterial. D-16.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; single; 3 months general surveying; 3 months construction; 2½ years detailing and checking structural shop drawings. Desires construction work or anything outside of drawing room in which previous drawing-room experience will be of value. Available on short notice. D-17.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 30; married; A.B. and M.S. degrees in civil engineering; advanced study in design and control of concrete mixtures; 6 months assistant city engineer; 4½ years railroad construction and maintenance. Location immaterial. Available for engineering construction, maintenance, or as college instructor. C-9537.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 8 years varied structural experience on design and construction, railroads, subways, buildings, bridges, estimates, inspection, and surveys. Capacity to assume responsibility. Desires connection with construction company, consultant, contractor, or architect—preferably in field of engineering construction or related work; also sales engineering or instructorship. C-2605.

GENERAL BUILDING CONSTRUCTION ESTIMATOR; Jun. Am. Soc. C.E.; 29; married; graduate civil engineer; capable and accurate A-1; 6 years experience. Can take complete charge of problems in the field and office on all types of general building construction. Desires position. Available at once. C-5869.

CIVIL AND INDUSTRIAL ENGINEER; M. Am. Soc. C.E.; graduate. Experience covers complete charge of design and construction, including preliminary investigations, studies, and estimates of industrial plants, housing groups for state institutions and private interests, and hydro-electric power houses—also all mechanical and architectural work connected therewith. Highest references. B-2835.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; single; graduate, Massachusetts Institute of Technology; 1 year surveying; 2 years concrete draftsman; 2 years designer and detailer light steel structures; 2 years concrete designer large hydro-electric projects. Excellent draftsman. Desires connection as field engineer or structural designer. Location immaterial. Available at once. C-7385.

ARCHITECTURAL ENGINEER; Jun. Am. Soc. C.E.; single; graduate, Ohio State University, 1929. Experience includes 2 summers on building construction; 1 year architectural and structural design on public utilities projects; 1½ years storm sewer and pavement design and inspection in city of 70,000 population. Location immaterial. D-35.

PULP AND PAPER MILL ENGINEER; Assoc. M. Am. Soc. C.E.; 25 years experience with prominent consulting engineers and paper manufacturers in general study and layout of mill, equipment, and piping; architecture, design of foundations and structures, writing of specifications, and supervising of work in the office and field. B-4177.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; married; university graduate; special training and experience in hydraulics, hydrology, mathematical statistics; can take charge of topographic, sanitary, or river surveys. Prefers technical work. Will consider instructorship, research assistantship, or work on water power. Location immaterial. D-50.

DESIGNING AND CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; 33; experienced in heavy construction, subways, tunnels, foundations, underpinnings, soil testings, estimating, bidding, scheduling, and running work. Wide contacts; best references. Desires position in executive capacity with engineering firm or university. Eastern states only. C-9867.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on pages 87 to 89 of the Year Book for 1931. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

DESIGN OF DAMS. By F. W. Hanna and R. C. Kennedy. New York, McGraw-Hill Book Co., 1931. 456 pp., illus., diagrs., charts, maps, tables, 9 × 6 in., cloth. $5.

A comprehensive treatise on the theory and practice of the design of solid and deck gravity, single and multiple arch, earth and rock-fill dams, and their accessories. In addition, the book discusses reservoir and dam-site surveys, rainfall, and the run-off of streams, and hydraulics and measurements of stream flows. A chapter is devoted to dam failures and their causes.

ELASTIC ARCH BRIDGES. By C. B. McCullough and E. S. Thayer. New York, John Wiley & Sons, 1931. 372 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth. $5.

A discussion of the mathematical theory of elasticity as applied to the design of arch bridges, with special reference to certain recent developments in arch analysis. The aim has been to develop a definite, coherent method of thinking upon the problem, rather than to compile a manual of design. The book is illustrated by photographs of arch bridges designed and constructed by the authors.

EXAMINATION OF WATER, CHEMICAL AND BACTERIOLOGICAL. By W. P. Mason. 6 ed. revised by A. M. Buswell. New York, John Wiley & Sons, 1931. 224 pp., illus., diagrs., charts, maps, tables, 9 × 6 in., cloth. $3.

For over 30 years, this book has been widely used by students and analysts. The new edition follows earlier ones closely, but the terminology has been brought up to date, and recent analytical procedures have been added.

INDUSTRIAL ENGINEERING AND MANAGEMENT. By R. M. Barnes. New York & London, McGraw-Hill Book Co., 1931. 366 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth. $3.50.

The fundamental principles are here presented with concrete illustrations drawn from successful industrial practice. Six chapters are devoted to factory design and equipment, and seven to time and motion study, wages, and manufacturing costs. The method of designing a new manufacturing plant is described in detail in an appendix. A select and useful bibliography is included.

PETROLEUM ENGINEERING HANDBOOK. 2 ed. Los Angeles, Calif., Palmer Publications, Inc., 1931. 461 pp., illus., diagrs., charts, tables, 12 × 9 in. cloth. $5.

The second edition of this handbook contains a collection of new papers by various experienced men upon recent technical developments in the industry. Among the subjects treated are the following: appraisal methods, cementing practice, evaporation, storage, fire protection, pipe lines, pumping, repressuring, and vapor-phase treatment. The catalog section supplies a guide to manufacturers of equipment.

PETROLEUM IN THE UNITED STATES AND POSSESSIONS. By R. Arnold and W. J. Kemnitzer. New York & London, Harper Brothers, 1931. 1052 pp., maps, charts, tables, 10 × 6 in., cloth. $16.

An exhaustive encyclopedic review of the history and development of petroleum production in this country. The geology, technology, and economics of each field are presented, and the situation in the non-productive states is also reviewed. An immense amount of statistical information is tabulated. Ample and select bibliographies are included. The book will be indispensable to students of the oil industry.

PRACTICAL HANDBOOK OF WATER SUPPLY. By F. Dixey. London, T. Murby & Co.; New York, D. Van Nostrand Co., 1931. 571 pp., illus., diagrs., charts, maps, tables, 9 × 6 in., cloth. $8.50.

This work is especially concerned with the problem of small water supplies, such as are needed by small settlements in new countries, and is intended as a practical guide to inexperienced persons. The construction of cisterns and small dams for impounding surface waters, the recovery of groundwater by wells of various types, and simple methods of purifying water are treated in considerable detail. The book is based upon the experience of the author in his work as Director of the Geological Survey of Nyasaland.

1931 SUPPLEMENT TO BOOK OF A.S.T.M. STANDARDS. Philadelphia, American Society for Testing Materials, 1931. 144 pp., 9 × 6 in., paper, $1.50.

This supplement brings up to date the 1930 Book of Standards published by the association. It contains 32 standards—17 of which are new and 15 replacements of former ones. Among them are specifications for alloy-steel bolting material for high-temperature service; welded wrought-iron pipe; high-test gray-iron castings; aluminum-alloy sheets and castings; hydrated lime; structural clay tile; white and red lead; and bronze powders. Methods are given for testing concrete, brick, pigments, slate, insulating oils, and other materials.

THEORY OF SIMPLE STRUCTURES. By T. C. Shedd and J. Vawter. New York, John Wiley & Sons, 1931. 345 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth. $3.75.

In this textbook for students in engineering schools, the authors endeavor to impart the ability to solve problems in structural analysis by giving the student a thorough understanding of the underlying principles. A simple but thorough discussion of the essential fundamental laws of statics and their application to simple structures is given, with a large number of problems.

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Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in the Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, or technical translations of the complete text may be obtained when necessary at cost.

BRIDGES

Bascule, Relocation. Jacks Raise 3,300-Ton Bridge 11½ Ft. to New Grade, P. G. Lang, Jr. *Construction Methods*, vol. 13, no. 9, Sept. 1931, pp. 54–57, 9 figs. Details of relocation of movable span, steel truss, railroad bridge by Baltimore & Ohio Chicago Terminal Railroad Co.; during jacking operations the bridge was maintained in an open position.

Concrete, Construction. Building the Boundary Channel Bridge. *Contractors and Engrs. Monthly*, vol. 23, no. 3, Sept. 1931, pp. 41–44 and 59, 7 figs. Methods and organization used on the largest of 12 bridges on the Mt. Vernon Memorial Highway; the bridge is a reinforced concrete cantilever structure having a channel space of 100 ft. with wing walls 75 ft. in length and carrying a 60 ft. roadway and two 6-ft. sidewalks.

Concrete Arch, Great Britain. Hampton Court Bridge and Road. *Concrete and Constr. Eng.*, vol. 26, no. 9, Sept. 1931, pp. 503–510, 4 figs. Design and construction of a concrete-arch bridge consisting of a central span of 105 ft. and two side spans of 90 ft. each; a space of 70 ft. between parapets, allowing for a 40-ft. carriageway and two 15-ft. footpaths; construction of abutments and piers.

Highway, Design. Limiting Conditions for Position of Bridges on Curved Highways, V. A. Eberly. *Roads and Streets*, vol. 71, no. 9, Sept. 1931, pp. 374–375, 1 fig. Method of computing curb, gutter, and bridge seat elevations where super-elevated roadway crosses bridge.

New Zealand. Waihou River Bridge, Kopu, and Piled Foundations, A. J. Baker, *New Zealand Soc. Civil Engrs.—Proc.*, vol. 17, 1930–1931, pp. 371–386, and (discussion) 386–402, 10 figs. Construction of a highway bridge having a total length of 1,520 ft. and made up of twenty-three 60-ft. plate girder spans and a central swing span of 140 ft. costing 54,000 pounds sterling.

Plate Girder, Construction. Shipping and Erecting 154-Ft. Plate Girders, S. Hardesty. *Eng. News-Rec.*, vol. 107, no. 12, Sept. 17, 1931, pp. 452–453, 2 figs. Methods used in construction of the west approach of the high-level suspension bridge, now being built over the Maumee River in Toledo, Ohio; use of locomotive cranes and loading bolsters.

Railroad, United States. Ninety-Four Years of Bridges at Harpers Ferry, P. G. Lang, Jr. *Eng. News-Rec.*, vol. 107, no. 12, Sept. 17, 1931, pp. 446–448, 3 figs. Evolution from the covered timber "arches" of 1836 to Bollman iron trusses and on to modern steel structures; Potomac River crossing of Baltimore and Ohio Railroad has made bridge history as well as reflected the changes in railroad rolling stock and operating practices.

Rigid Frame, Testing. Deflection Tests Show Rigidity of Steel Rigid-Frame Bridges, R. M. Hodges. *Eng. News-Rec.*, vol. 107, no. 10, Sept. 3, 1931, p. 371, 1 fig. Report on load-deflection tests, recently made on three structural-steel rigid-frame bridges in Westchester County, New York, showing very small deflections in comparison with what would be expected for ordinary steel girder bridges of equal spans; deflection-test layout.

Texas. High-Strength Concrete Used in New Fort Worth, Tex., Bridge, C. M. Thelin. *Eng. News-Rec.*, vol. 107, no. 14, Oct. 1, 1931, p. 527, 2 figs. Construction of Royal Street Bridge, Fort Worth, Tex., consisting of 14 concrete beam-and-girder spans of 48 ft. each and one open spandrel four-rib arch of 124-ft. span; all parts of the structure above the footings designed for 3,500-lb. concrete, using 1,200 lb. per sq. in. for negative moment.

Wooden. Creosoted Timber for Highway Structures, P. Philip. *Contract Rec.*, vol. 45, no. 39, Sept. 30, 1931, pp. 1173–1176, 1 fig. Creosote treatment; building up of protective layer; framing prior to treatment; Quesnel Bridge; laminated construction; creosoted timber cribs, guard rails and posts, sidewalks, and culvert pipe.

BUILDINGS

Earthquake Resistance. The Prevention of the Disastrous Effects of Earthquakes, J. R. Baird. *New Zealand Soc. Civil Engrs.—Proc.*, vol. 17, 1930–1931, pp. 414–420 and (discussion) 420–423. Elementary principles of earthquake-resisting design of buildings and other structures.

New York. Building for Economy and Efficiency, J. A. Fouilhoux. *Eng. News-Rec.*, vol. 107, no. 15, Oct. 8, 1931, pp. 560–565, 11 figs. Planning and construction of 33-story building for McGraw-Hill publishing house in New York; functional planning produces structure adapted to highly exacting services at an exceptionally low cost; mass arrangement; zoning helped planning; vibration prevented by mounting presses on pads of plank and cork, by placing deep knee-brackets at all beam-to-column connections, and by using 8-in. cinder concrete floor; wall construction of alternate courses of blue terra cotta and steel sash and glass; masonry piers eliminated, and windows made continuous between columns; elevator arrangement.

CITY AND REGIONAL PLANNING

St. Paul, Minn. City Planning in St. Paul, G. H. Herrold. *City Planning*, vol. 7, no. 4, Oct. 1931, pp. 217–224, 3 figs. Survey of special studies made and features of plan evolved; park acquisitions.

CIVIL ENGINEERING

Geology. Economics of Geology as Applied to Engineering, D. Yorke. *Surveyor*, vol. 80, no. 2063, Aug. 7, 1931, pp. 139–141, 5 figs. Bearing of geology on the design of water works, sewage disposal works, road work, excavations, foundations of buildings and bridges, tunneling, and town planning.

CONCRETE

Aggregates, Light Weight. Light Weight Aggregate, A. W. Munsell. *Engrs. and Eng.*, vol. 48, no. 9, Sept. 1931, pp. 210–214 and (discussion) 214–215, 3 figs. Report of the Port of New York Authority's tests of haydite and celite for their structural soundness and concrete making properties.

Beams, Concrete, Design. The Design of Doubly-Reinforced T-Beams, with Special Reference to Those in Which the Depth of the Slab Is Less Than the Depth of the Neutral-Axis, T. Wooltorton. *Indian Eng.*, vol. 90, no. 8, Aug. 22, 1931, pp. 162 and 164–165, 2 figs. Construction of graphical charts for design of double reinforcement; numerical examples.

Cement Handling. The Use of Cement in Bulk, H. Coffman. *Am. Concrete Inst.—Journal*, vol. 3, no. 1, Sept. 1931, pp. 37–58, 23 figs. Report of Committee 607; handling cement at point of manufacture; transportation; handling cement at destination; containers; special all-steel cement cars; notable examples of use of bulk cement.

Construction, Costs. Estimating Cost of Concrete Work—IV, L. H. Allen. *Concrete*, vol. 39, no. 3, Sept. 1931, pp. 21–22. Concreting plant; cold weather expense; insurance; estimated costs.

Costs. Production Data on Ready-Mix Concrete, F. C. Wilcox. *Concrete Products*, vol. 40, no. 9, Sept. 1931, pp. 31–34, 2 figs. Tabulated summary of operating, production, and material costs, and of selling prices, in twenty commercial and individual plants in twelve different states; an analysis of costs and gross margins.

Design. Cutting Corners in Concrete Structural Design—II, J. R. Goetz. *Concrete*, vol. 39, no. 4, Oct. 1931, pp. 15–18, 2 figs. Charts for the design of beams and slabs where clearance requirements force the use of shallow depths; compression steel in concrete beams and over-reinforced slabs.

Mixing. Proportions for Concrete Computed From Data on Aggregates, A. A. Smith. *Concrete*, vol. 39, no. 3, Sept. 1931, pp. 17–19. Formula giving close approximation to ideal proportions after aggregates are analyzed; example illustrating method of procedure.

Ready Mixed. The Merits of Truck Mixed Concrete. *Contract Rec.*, vol. 45, no. 37, Sept. 16, 1931, pp. 1111–1113. Report of the Committee of the American Road Builders' Assn.; results of investigations; damage to subgrade; water control and transfer of material.

Roads. Jointless Concrete Roads and Walls, J. H. Walker. *Structural Engr.*, vol. 9, no. 10, Oct. 1931, pp. 352–356, 2 figs. Outline of "plumcrete" and "anchorete" systems of road slab construction; use of hexagonal steel hoops, or of grooved subgrade, prevents the formation of visible cracks as the concrete dries and shrinks.

Specifications. Federal Government Specification, W. D. M. Allan. *Concrete Products*, vol. 40, no. 9, Sept. 1931, pp. 29–30. Requirements of new specification of the Federal Specifications Board.

CONSTRUCTION INDUSTRY

Cost Estimating. Fundamentals of Estimating, G. V. Maconi. *Gen. Bldg. Contractor*, vol. 2, no. 10, Oct. 1931, pp. 28–30, 1 fig. Outline of basic principles; material cost; labor cost; subcontracts; job overhead and plant charges; preliminary progress schedule; contractor's fee; variations in estimates.

Costs. Current Construction Unit Prices. *Eng. News-Rec.*, vol. 107, no. 14, Oct. 1, 1931, pp. 548–549, 1 fig. Unit prices bid on Madden Dam in Panama Canal Zone.

Fire Prevention. Reducing Fire Hazards in Buildings Under Construction, W. B. White. *Safety Eng.*, vol. 62, no. 2, Aug. 1931, pp. 87–91, 4 figs. Change from wood to steel for temporary construction equipment; review of revolutionary developments in building construction methods; details of the Sherry-Netherlands Hotel fire in New York.

Statistics. Cut the Red Tape and Let's Have It. *Gen. Contractors Assn.—Bull.*, vol. 22, no. 7, Aug. 1931, pp. 173–175. Recommendations for speeding up Federal, state, and local public and semi-public projects to relieve unemployment in the United States; statistical data on Federal projects; construction by states.

DAMS

Concrete. Some Important Factors in the Design and Construction of Masonry Dams, H. J. F. Gourley. *Civil Eng. (Lond.)*, vol. 26, no. 302, Aug. 1931, pp. 33–37, 5 figs. Uplift pressure in gravity dams; materials and methods of construction; arched gravity dams; arched dams.

Concrete Gravity, Arkansas. Carpenter Dam and Power House Built Within Two Coffers on Ouachita River, Arkansas, L. G. Warren. *Construction Methods*, vol. 13, no. 10, Oct. 1931, pp. 34–37, 9 figs. Construction of concrete-gravity dam 80 ft. high, carrying ten steel spillway gates, Taintor type, each 26 ft. high and 34 ft. wide; power house is designed for two 40,000-hp. generators.

Construction. Cofferdamming the Columbia at Rock Island—a Real Construction Battle. *Stone and Webster Journal*, vol. 48, no. 7, July 1931, pp. 470–479, 5 figs. Similar description previously indexed from *Eng. News-Rec.*, Apr. 30, 1931.

Earth Fill, Corewalls. The Application of Compressed Air in Deep Trench Sinking, E. M. Moir. *Civil Eng. (Lond.)*, vol. 26, no. 302, Sept. 1931, pp. 30–31, 2 figs. Use of compressed air for sinking 200-ft. deep trench in construction

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of cut-off for Silent Valley reservoir dam; medical air lock used.

GRAVITY MASONRY. The Stability and Drainage of Cyclopean Masonry Dams, S. T. Farnsworth. *Commonwealth Engr.*, vol. 19, no. 1, Aug. 1, 1931, pp. 5–16, 19 figs. Design and construction of two cyclopean masonry gravity dams in the Sydney water supply area, known as Cordeaux and Avon dams; preparation of the foundations and grouting; galleries, drains, and pressure pipes; vertical rubber drains; relation between total leakage and stored water; uplift pressure readings; variation of foundation pressures with time; vertical expansion joints; temperature effects.

NEW ZEALAND. The Huia Water Supply Extension for the City of Auckland, A. D. Mead. *New Zealand Soc. Civil Engrs.—Proc.*, vol. 17, 1930–1931, pp. 145–167, 7 figs. This paper treats principally the construction of a concrete gravity dam 125 ft. high which cost about 232,000 pounds sterling.

RESERVOIRS, CONCRETE, GREAT BRITAIN. New Reservoirs at Godalming. *Water and Water Eng.*, vol. 33, no. 394, Sept. 21, 1931, pp. 467–470, 4 figs. Design and construction of two covered concrete reservoirs, 600,000 and 900,000 gal. in capacity.

UTAH. Construction of the Echo Dam on the Salt Lake Basin Project, Utah, K. B. Keener. *New Reclamation Era*, vol. 22, no. 10, Oct. 1931, pp. 214–216, 2 figs. Features of an earth-fill dam 151 ft. high above bedrock, and 1,840 ft. long; foundation and material tests; construction methods; spillway and stilling pool.

FLOOD CONTROL

ALLUVIAL RIVERS. Flood Control on Alluvial Rivers—I, F. H. Tibbetts. *Eng. News-Rec.*, vol. 107, no. 14, Oct. 1, 1931, pp. 520–524, 2 figs. Principles governing the planning of flood control; methods of flood control by-passes, storage or detention reservoirs, and channel improvements, with special reference to levees; hazards of high levees; reforestation; channel shortening.

FLOW OF FLUIDS

FLOW OF AIR, MEASUREMENT. Measurement of Air Flow—VII, E. Ower. *Instruments*, vol. 4, no. 8, Aug. 1931, pp. 445–454, 2 figs. Mathematical discussion of the effects of fluctuating wind and the variation in wind speed across vane circle.

WIND TUNNELS, GREAT BRITAIN. Compressed-Air Wind Tunnel of National Physical Laboratory, E. F. Relf. *Engineering*, vol. 132, no. 3429, Oct. 2, 1931, pp. 428–433, 14 figs. partly on supp. plate. Reasons which led to building a tunnel of this type; design and construction of tunnel; nature of apparatus which is to be used to make measurements in it. Before Brit. Assn.

FOUNDATIONS

MACHINERY. Noise Elimination in the Shop, E. S. Penn. *Am. Mach.*, vol. 75, no. 11, Sept. 10, 1931, p. 422, 2 figs. Cork foundations or pads absorb the vibration and thus diminish or entirely eliminate noise.

RETAINING WALLS. The Design of Piled Retaining Walls, R. J. Grant. *Engineering*, vol. 132, nos. 3475 and 3476, Sept. 4, 1931, pp. 274–278 and Sept. 11, pp. 335–338, 12 figs. Investigation, from a theoretical point of view, which evolves a means of calculating both the maximum bending moment and depth to which piles should be driven on assumption that the soil is of a nature presupposed by an angle of repose, weight of soil, and earth-pressure formula.

TESTING. Report of Committee on Boston Subsoils. *Boston Soc. Civil Engrs. Journal*, vol. 18, no. 7, Sept. 1931, pp. 243–283, maps at back of book. Data regarding the character of subsoils in Boston and adjacent areas; tabulation of 3,900 borings in Boston and Cambridge made by owners and contractors.

HYDRAULIC ENGINEERING

FAILURE. Notes on Some Failures and Unforseen Factors in the Design of Works, H. H. Dare. *Inst. Engrs. Australia—Journal*, vol. 3, no. 7, July 1931, pp. 247–254, 17 figs. Bridges, canals, tunnels, weirs, and other hydraulic structures, within author's experience, which have failed, wholly or in part, chiefly due to the agency of water, either in motion or at rest; deterioration of channel lining; Burrinjuck Dam spillways.

GATES. Torrens Lake Sluice Gates, R. M. Scott. *Inst. Engrs. Australia—Journal*, vol. 3, no. 8, Aug. 1931, pp. 269–278, 19 figs. Design and construction of two gates of Stoney type, intended to reduce silting, measuring 22 ft. by 22 ft. 6 in. in height; hydrographic and discharge data; graphs showing connection between height of gate opening and discharge; details of roller and roller path; operation of sluice gates; cost of various works; controlling extreme floods.

HYDRO-ELECTRIC POWER PLANTS

JAPAN. Japan's Hydro-Electric Power and Its Exploitation, C. Mori. *World Power Conference. Tokyo Sectional Mtg.—Trans.*, vol. 2, Oct. 29–Nov. 7, 1929, pp. 197–212. Indexed in Engineering Index 1930, p. 902, from *Water and Water Eng.*, July 21, 1930.

SAFE HARBOR, PA. Safe Harbor. *Contractors and Engrs. Monthly*, vol. 23, no. 3, Sept. 1931, pp. 62–68, 12 figs. Organization and equipment for the construction and installation of initial 255,000 hp., of Safe Harbor Hydro-electric Power Plant on the Susquehanna River, near Columbia, Pa.; construction of Stoney gate concrete gravity dam, 75 ft. high; limestone and trap quarry developed; construction plant; handling of fine aggregate; central concrete mixing plant; weighing batches, transporting and placing concrete; winter concreting; excavation and clean-up of tailrace; construction camp.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

CYCLES. Is Our Climate Changing? J. R. Jahn. *West. Construction News*, vol. 6, no. 18, Sept. 25, 1931, pp. 492–494, 6 figs. Study of long term rainfall records of the Northwestern states, including northern California; statistical evidence indicates that the area north of Bakersfield, Calif. and west of Utah has entered an era of diminishing rainfall, the length of which may be measured in decades.

RAIN AND RAINFALL, CALIFORNIA. Rainfall and Stream Run-Off in southern California since 1769, H. B. Lynch. *West. City*, vol. 7, no. 9, Sept. 1931, pp. 19–20, 1 fig. Abstract of a report made to the Southern California Metropolitan Water District; data consist of rainfall measurements since 1850, crop records at 11 of the Spanish missions between 1774 and 1834, elevations of Lake Elsinore since 1810, and similar information.

SEISMOGRAPHS. Coming to Grips with the Earthquake Problem, N. H. Heck. *Franklin Inst.—Journal*, vol. 212, no. 3, Sept. 1931, pp. 269–303, 24 figs. Various types of seismometers and seismographs, their characteristics and performance; application of instruments; effects of earthquakes on structures of various kinds; earthquake-resisting structures.

INDUSTRIAL BUILDING

COKE PLANTS, GREAT BRITAIN. Coke-Oven Plant at Beckton Gas Works. *Concrete and Constr. Eng.*, vol. 26, no. 9, Sept. 1931, pp. 517–526, 2 figs. Detailed description of the coke-oven plant, now in the course of erection at the Beckton Works of the Gas Light & Coke Co., will have a capacity of 1,200 tons of coal daily.

ELECTRIC POWER. Load Control in Industrial Plants, R. R. Ruggles. *Power Plant Eng.*, vol. 35, no. 18, Sept. 15, 1931, pp. 935–937, 4 figs. Advantageous application of load regulation illustrated by the hypothetical case of an industrial plant with a fluctuating load which purchases power from a large central station but is also equipped to generate a certain portion of its total load requirements; typical wiring diagram of an automatic load regulator working on a prime mover.

SWITZERLAND. The Engineering Works of Escher Wyss & Company. *Metal Industry (Lond.)*, vol. 39, no. 14, Oct. 2, 1931, p. 328. Works are in Zurich and date from the year 1805, first machines made being for the cotton-spinning industry; main shops have an area of 161,000 sq. ft.; the whole building is subdivided into 15 bays; details of foundries and boiler shops.

IRRIGATION

CANALS, GATES. Report on the Installation and Testing of Various Types of Radial Gates on the 84-Mile Jamrao Canal, C. G. Hawes. *Gov. Bombay Pub. Works Sept.—Tech. Paper*, no. 35, 1931, 6 pp., 11 figs. on supp. plates. Report on operating tests of Walker triform gates, and tension hung counterbalanced gates; working of the gates and the operating gear.

OREGON. Irrigation Proves Success Where Annual Rainfall is 40 In. *Eng. News-Rec.*, vol. 107, no. 14, Oct. 1, 1931, p. 524. Report on experiments conducted by the Oregon Agricultural Experiment Station on field, truck garden, and fruit crops which have demonstrated that agricultural production in the Willamette Valley can profitably pay the cost of irrigation; supplemental irrigation during the summer months is proving successful in many lines.

OWYHEE, WASH. Owyhee Irrigation Project, Oregon-Idaho, P. Schuyler. *West. Construction News*, vol. 6, no. 14, July 25, 1931, pp. 381–385, 12 figs. Progress report on construction of irrigation project including a curved concrete gravity dam 530 ft. high, above bedrock, and 835 ft. long.

MATERIALS TESTING

CONCRETE. Tests of Concrete Conveyed from a Central Mixing Plant, W. A. Slater. *Nat. Sand and Gravel Bul.*, vol. 21, no. 9, Sept. 15, 1931, pp. 9–16 and (discussion) 17–19, 8 figs. Paper before Am. Soc. Testing Matls. previously indexed from their Advance Paper no. 56, for mtg. June 22–26, 1931.

EXTRUSION. The Extrusion of Metals—IV, C. A. Colombel. *Rolling Mill Journal*, vol. 5, no. 9, Sept. 1931, pp. 599–600. Extrusion ratio; effect of lubrication; effect of rate and temperature.

FATIGUE. The Influence of Rapidly Alternating Loading on Concrete and Reinforced Concrete, E. Probst. *Structural Engr.*, vol. 9, no. 10, Oct. 1931, pp. 326–340, 14 figs. Report on long series of tests made in the laboratories of the Karlsruhe Institute of Technology; the effect on alternating axial compression or tension loadings, also on strains and stresses in beam section under bending moments and on formation of cracks.

HARDNESS TESTING, BRINELL. A Contribution to Brinell Ball Hardness Tests, M. Ichihara. *Tohoku Imperial Univ.—Technology Report*, vol. 10, no. 1, 1931, pp. 25–41, 16 figs. Experiment to measure how metallic surfaces are deformed when Brinell ball immerses them; cross-sectional curves of indentations were measured optically; empirical formula is given, applicable with error less than .002 mm. in regard to all observed metals.

IRON AND STEEL, YIELD POINT. The Phenomenon of Tensile Yield in Mild Steel and Iron, J. G. Docherty and F. W. Thorne. *Engineering*, vol. 132, no. 342, Sept. 4, 1931, pp. 295–297, 15 figs. Experiments carried out in the Engineering Laboratory of the Royal Naval College, Greenwich, to determine conditions under which real phenomena of yield may be studied with standard apparatus. Before Brit. Assn.

METALS, COLD WORKING. The Effect of Cold-Working on the Magnetic Susceptibility of Metals, K. Honda and Y. Shimizu. *Tohoku Imperial Univ.—Science Reports*, vol. 20, no. 3, July 1931, pp. 460–488, 9 figs. Effect of cold working or internal stress on magnetic susceptibility has not hitherto been systematically studied; writers measured this effect on 10 metals belonging to cubic system, namely, copper, silver, gold, lead, aluminum, platinum, rhodium, palladium, molybdenum, and barium; magnetic susceptibility of diamagnetic metals decreases in marked degree by cold working and that of paramagnetic metals also decreases. (In English.)

PAVEMENTS, CONCRETE. Studies of Paving Concrete, F. H. Jackson and W. F. Kellermann. *Pub. Roads*, vol. 12, no. 6, Aug. 1931, pp. 145–180, 37 figs. Tests for determining the effect of variations in the quantity of coarse aggregate upon strength, density, and other properties of concrete pavement slabs, placed and finished in accordance with normal field practice; relation between strength of slag concrete and cement factor; factors influencing honeycomb in slabs; relation between strength of stone concrete and water-cement ratio, also the type of finishing machine; effect of honeycomb on flexural strength of slabs; results of absorption tests; studies of individual test sections.

PORTS AND MARITIME STRUCTURES

BREAKWATERS, CONSTRUCTION. Port Arthur Harbor Breakwater Construction. *Contract Rec.*, vol. 45, no. 36, Sept. 9, 1931, pp. 1039–1095, 2 figs. Preliminary plans, preparations, and methods employed in timber and concrete type and in rubble mound type of breakwater.

PORT TERMINALS, NEW JERSEY. The Keel-to-Rail Terminal of the Pennsylvania Dock and Warehouse Company, Jersey City, N.J., W. H. Gilligan. *World Ports*, vol. 19, no. 10, Aug. 1931, pp. 1104–1112, 2 figs. Buildings occupy a rectangular plot of $8^1/_2$ acres having a frontage of 1,020 ft. along the Hudson River and extending back from the river 370 ft.; modern accommodations for offices, stores, and manufacturing cold and dry storage, and facilities for receiving, storing, and shipping goods by rail, trucks, and water. Before Soc. Terminal Engrs.

SEAWALLS, DESIGN. Design of Quay Walls, H. Savage. *Concrete and Constr. Eng.*, vol. 26, no. 9, Sept. 1931, pp. 511–516, 7 figs. Discussion of elementary principles with special reference to data for design; effect of buoyancy; resistance against forward movement.

RAILROADS, STATIONS, AND TERMINALS

FREIGHT, CHICAGO. Opens Notable Freight House on Air Rights Property. *Ry. Age*, vol. 91, no. 13, Sept. 26, 1931, pp. 471–473 and 478, 6 figs. Facilities of Chicago and Northwestern under Chicago Merchandise Mart comprise 2,700 lin. ft. of platforms and a capacity of 143 cars; arrangement of facilities; plan of freight house; ventilating facilities.

MILAN, ITALY. The New Central Station at Milan. *Ry. Gaz.*, vol. 55, no. 11, Sept. 11, 1931, pp. 330–341, 27 figs. Detailed description of the new station constructed by the Italian State Railways and claimed to be the largest on the European continent; arrangement of lines in Milan district, showing new and proposed alterations; station buildings; patent movable buffer stops; signaling installation; locomotive depot; details of Rawie buffer stop installation; general arrangement of running sheds and repair shops at Greco-Milanese; layout of station and approach tracks.

RELOCATION. Track Elevation for Joint Line and Union Station, G. R. Barte. *Eng. News-Rec.*,

vol. 107, no. 12, Sept. 17, 1931, pp. 449–452, 4 figs. At Dayton, Ohio, old canal forms site for relocated line used by four railways; elevated tracks pass union station and have inclines to yards and industries; structural features; track and traffic study; retaining walls and bridges.

ROADS AND STREETS

CONNECTICUT. Asphalt-Hardened Shoulders in Connecticut, C. S. Hill. *Eng. News-Rec.*, vol. 107, no. 12, Sept. 17, 1931, pp. 444–445, 6 figs. Asphalt-penetrated tar-sealed shoulders of roadside soil increase travel width, reduce edge breaks, and cut maintenance costs; description of zigzag hone for heavy cutting and shaping.

EXPERIMENTAL, MISSOURI. Missouri Builds Experimental Types of Highway Resurfacing. *Concrete*, vol. 39, no. 3, Sept. 1931, pp. 9–10, 2 figs. Construction of four types under test near Joplin, including 4-in. reinforced-concrete slab 1/4 mile long, and penetration macadam section 1 1/4 miles long.

GRADING. Grading Methods and Equipment, H. J. Spelman. *Can. Engr.*, vol. 61, no. 9, Sept. 1, 1931, pp. 22–23 and 50.—Report of committee of American Road Builders' Assn.; soil analysis and laboratory control; compaction methods; power road rollers; wheel type equipment. (To be continued.)

LOW COST. The Construction of Low-Cost Surfaces on Secondary Roads, J. G. Cameron. *Contract Rec.*, vol. 45, no. 39, Sept. 30, 1931, pp. 1165–1166 and 1170, 1 fig. Canada's road mileage; rural roads; cold pre-mixed bituminous roads; low cost surfaces at 30 cents per sq. yd.

MACADAM, MAINTENANCE AND REPAIR. Simple Patching Method for Smoothing Macadam, J. R. McDermott. *Eng. News-Rec.*, vol. 107, no. 16, Oct. 15, 1931, p. 617, 2 figs. Description of poured, or retread patching, used in eastern section of West Virginia; skillfully done it produces remarkably smooth surfaces on macadam roads roughened by long service.

SOUTH AFRICA. Highway in Southern Rhodesia, L. Scott. *Surveyor*, vol. 80, no. 2069, Sept. 18, 1931, pp. 271–272, 7 figs. Road-making on virgin soil; concrete track roads; method of construction; cement bound carpeting.

SURFACE TREATMENT, CALCIUM CHLORIDE. Maintaining Dustless Roads, A. Burton. *Contract Rec.*, vol. 45, no. 39, Sept. 30, 1931, pp. 1187–1188. Economy of calcium chloride; hard-surfaced vs. unpaved roads; how calcium chloride works on gravel.

SEWERAGE AND SEWAGE DISPOSAL

GERMANY. The Status of Sewage Treatment in Germany, A. Heilmann. *Sewage Works Journal*, vol. 3, no. 1, Jan. 1931, pp. 76–85, 5 figs. Status of various sewage treatment processes; racks and screens; grease traps; grit chambers; settling tanks; digestion tanks; copper coils for hot water used for heating sludge at Halle; biological treatment; trickling filters; contact filters; activated sludge; chemical processes; industrial wastes.

GREASE REMOVAL. Los Angeles Method of Grease Removal, G. A. Parkes. *Sewage Works Journal*, vol. 3, no. 3, July 1931, pp. 377–379, 1 fig. Description and results of the operation of the Los Angeles type grease skimmer; cost estimated at 15 to 30 cents per million gallons. Before Calif. Sewage Works Assn.

INCINERATORS. Design Details and First Year's Operating Results of a Screenings Incinerator, M. W. Tatlock. *Mun. Sanitation* vol. 2, no. 9, Sept. 1931, pp. 428–430, 2 figs. Description of screenings incinerators of Dayton, Ohio, sewage treatment plant; material handled; fuel required; total operating cost.

INDUSTRIAL WASTES. Recovery of Proteins from Packing House Waste by Super-Chlorination, H. O. Halvorson, A. R. Cade, and W. J. Fullen. *Sewage Works Journal*, vol. 3, no. 3, July 1931, pp. 488–501, 5 figs. Report on experimental study and operation of plant at Austin, Minn.; effect of chlorine on various proteins; effect of chlorine on mixtures of proteins and their decomposition products; effect of varying chlorine concentration on albumin solutions; effect of pH on precipitation of albumin with chlorine; layout of waste treatment plant, George A. Hormel & Co., Austin, Minn. Bibliography. Before Central States Sewage Works Ass'n.

RUSSIA. Twelfth Report (1930) of the Sewage Commission of the City of Moscow, S. N. Stroganoff. *Sewage Works Journal*, vol. 3, no. 1, Jan. 1931, pp. 147–153. Review of the results of research studies over a period of 25 years, presented in a series of 26 papers.

STREET CLEANING AND REFUSE DISPOSAL

GERMANY. Collection and Disposal of Refuse in Germany, Schroeder. *Surveyor*, vol. 80, no. 2063, Aug. 7, 1931, pp. 149–150, 1 fig. Survey of recent practice of German municipalities; small-bin system; large-bin emptying system; bin changing system. Before First Inst. Conference on Pub. Cleansing.

MUNICH. Street Cleaning in Munich, W. J. Spiegelberg. *Mun. Sanitation*, vol. 2, no. 10, Oct. 1931, pp. 481–483, 8 figs. Equipment; working methods; cleaning columns; description of garbage truck with snow plow attachment.

UNITED STATES. A Survey of Practices in Refuse Disposal in American Cities, R. J. Bounds. *Mun. Sanitation*, vol. 2, no. 9, Sept. 1931, pp. 431–435, 3 figs. Abstract of a report to the Civic Development Department, Chamber of Commerce of the United States; dumping on land; dumping at sea; sanitary fill; fermentation; burial; reduction; incineration; early experiences; operating cost data.

STRUCTURAL ENGINEERING

ARCHES, MASONRY, DESIGN. Masonry Arches, G. H. Hargreaves. *Surveyor*, vol. 80, no. 2067, Sept. 4, 1931, pp. 235–237, 7 figs. Elementary theory of arch design and construction; graphical charts giving approximate dimensions of arch elements; widening and strengthening; check on design.

CONCRETE DESIGN, CHARTS. Short-Cuts in Structural Design—V, J. R. Griffith. *Concrete*, vol. 39, no. 4, Oct. 1931, pp. 29–30, 2 figs. Chart for determining pressure against foundation walls when height and character of earth fill are known.

FLOORS, BATTLEDECK. Battledeck Floor Construction. *West. Machy. World*, vol. 22, no. 9, Sept. 1931, pp. 407–408, 4 figs. Type of floor construction endorsed by the American Institute of Steel Construction as an efficient and practical building method; it makes possible lighter and less expensive building with distinct advantages in strength and rigidity.

ROOFS, ARCH. Pointed-Arch Roofs. *Eng. News-Rec.*, vol. 107, no. 15, Oct. 8, 1931, pp. 583–584, 1 fig. Principles of design and merits of laminated-wood, Gothic arch roofs; circular curve passing through three points of intersection of dead and wind load parabolas outlines stable form of pointed arch.

STEEL STRUCTURES, RESEARCH. British Investigations of Steel Structures. *Engineering*, vol. 132, no. 3427, Sept. 18, 1931, pp. 348–352, 12 figs. Account of work being carried out by the Department of Scientific and Industrial Research, Steel Structures Research Committee, at the Building Research Station at Garston; main subjects being studied relate to loads on floors, strains in buildings, analysis of stress, specifications and properties of materials, properties of welded connections, and effects of vibration.

SURVEYING

AERIAL. Contract Mapping in the Louisville District, M. H. Wilson. *Military Engr.*, vol. 23, no. 130, July-Aug. 1931, pp. 340–344, 6 figs. Preparation of precise maps of the Upper Wabash River and a portion of the East Fork of the White River, Indiana, by aerial photography, exclusively; test profile lines and "area tests"; field test of contract maps; aerial mapping methods.

GEODETIC SURVEYING, TRIANGULATION. Triangulation System in Canada. *Can. Engr.*, vol. 61, no. 7, Aug. 18, 1931, p. 18. Airplane methods of laying out a system of triangulation in Northern Ontario; economy of airplanes as a means of transport for laying out a system of triangulation over large areas.

TRAFFIC CONTROL

TRAFFIC SIGNS, SIGNALS AND MARKINGS, VACUUM TUBES. Electron Tubes in Traffic-Actuated Control Systems. *Electronics*, vol. 3, no. 3, Sept. 1931, pp. 94–96 and 123, 7 figs. Types so far developed are as follows: sound amplifying equipment, which amplifies the sound of the vehicle passing over the box in the street; pressure type detectors, using electrostatic timing method of charging condensers; electromagnetic control equipment, actuated by magnetic flux induced by a passing car; and photo-cell control; equipment actuated by interception of light beam; equipment and wiring diagram of electrostatic timing system illustrated.

TUNNELS

CONSTRUCTION. Attack Sandrock with Duckbills and Rockcutters, C. E. Swan, W. D. Bryson, and T. Foster. *Coal Age* vol. 36, no. 7, July 1931, pp. 349–350, 3 figs. Special features of the equipment and practice at rock tunnels driven by the Colony Coal Co. at Dines, Wyo., and by the Union Pacific Coal Co. at Winton, in which duckbills were used to push their way into the rock and forward it to shaker conveyor pans for loading; blower fan for ventilating; cycles of operation and crew organization. Before Rocky Mountain Coal Min. Inst.

RAILROAD, CANADA. Wolfe's Cove Terminal Tunnel, Quebec. *Can. Engr.*, vol. 61, no. 7, Aug. 18, 1931, pp. 9–11, 4 figs. Construction of railroad tunnel 1 mile long, 16 ft. wide, and 22 ft. 6 in. high; methods of excavation and concreting.

WATER SUPPLY TUNNEL, CONSTRUCTION. Tunnel Driving at Cobble Mountain, H. H. Hatch. *Eng. News-Rec.*, vol. 107, no. 13, Sept. 24, 1931, pp. 507–511, 5 figs. Comparison of shooting and mucking methods and costs on two tunnels in Springfield's new water supply and hydro-electric project; diversion tunnel 11 1/2 by 11 1/2 ft.; horseshoe section 1,550 ft. long; pressure tunnel has a total length of 7,080 ft. and is mainly 10 by 9 ft.; 4-in. horseshoe section, concrete lined; drilling and shooting schedules for various tunneling methods; various heading and bench methods tried; shooting diagram; costs.

WATER PIPE LINES

ASBESTOS-CEMENT. The Manufacture of the "Everite" Pipes for Water Mains. *Water and Water Eng.*, vol. 33, no. 394, Sept. 21, 1931, pp. 484–486, 9 figs. Description of process and factory of Asbestos Cement Building Products, Ltd., at Widnes; construction of several pipe lines built of Everite pressure pipes, 9 to 18 in. in diam.; details of detachable joints.

CONCRETE, CENTRIFUGAL CASTING. Centrifugally Cast Concrete Pipe for Phoenix, Ariz. Water System. *Concrete Products*, vol. 40, no. 9, Sept. 1931, pp. 15–22, 23 figs. Fabricating and laying of 31 miles of pipe line, 36 in. to 48 in. in diameter, features of steel centrifugally lined, gunited pipe; plant of American Concrete Pipe Co.; plant of United Concrete Pipe Corp.

CONSTRUCTION. High Efficiency Attained on Albany Pipe Construction. *Eng. News-Rec.*, vol. 107, no. 14, Oct. 1, 1931, pp. 534–535, 2 figs. Machine excavation used entirely on 20 miles of 40-in. cast-iron line; 75 per cent of the working time devoted to digging and laying; joint tests show remarkably low leakage factor.

WATER PUMPING PLANTS

DESIGN. Factors Governing Arrangement of Modern Pumping Stations, C. B. Burdick. *Eng. News-Rec.*, vol. 107, no. 13, Sept. 24, 1931, pp. 483–486, 5 figs. Evaluation of the following design factors: site topography and accessibility, water levels, expansion provisions, and good appearance; layout of Williams Creek water plant at Knoxville, Tenn.; interior finish.

EQUIPMENT. Great Economies Achieved by Modern Pumping Equipment, W. M. White. *Eng. News-Rec.*, vol. 107, no. 13, Sept. 24, 1931, pp. 486–487, 3 figs. Improvements in steam turbines and electric power generation; high efficiency within large range obtained by modern centrifugals; motor-driven pumps replace pumping engines in Detroit; up-to-date pumping equipment conserves space.

RAILROAD CROSSINGS, DRAINAGE. Highway Underpasses Drained by Automatic Pumping Plants, M. J. Ruark and C. E. Keefer. *Eng. News-Rec.*, vol. 107, no. 10, Sept. 3, 1931, pp. 372–373, 3 figs. Costs and capacities of drainage pumping stations; drainage pumps are driven through speed reducers; grade-crossing elimination causes difficult drainage problem at Baltimore, Md.; automatically operated pumping stations have been built to remove the surface drainage from depressed highways and adjacent low-lying territory.

WATER TREATMENT

ANALYSIS, FLUORIDE DETERMINATION. Occurrence of Fluorides in Some Waters of the United States, H. V. Churchill. *Indus. and Eng. Chem.*, vol. 23, no. 9, Sept. 1931, pp. 996–998, 7 figs. Discovery of presence of fluorides in deep-well water from Bauxite, Ark.; survey of some municipal supplies in the United States was undertaken and results are shown in table. Bibliography.

CHLORINATION, PRE-AMMONIATION. A Review of Water Treatment by Ammonia-Chlorine Process, H. E. Jordan. *Water Works Eng.*, vol. 84, no. 19, Sept. 23, 1931, pp. 1388, 1391–1392, 2 figs. Successful use of method in removing tastes and odors; special testing means; answering objections; Indianapolis experience with pre-ammoniation; testing method.

SOFTENING PLANTS, GREAT BRITAIN. Plant Installed at the Hams Hall Generating Station of the Birmingham Corporation Electricity Works. *Water and Water Eng.*, vol. 33, no. 394, Sept. 21, 1931, pp. 477–480, 6 figs. Detailed description of water softening and conditioning plant installed by United Water Softeners, Ltd., designed for a capacity of 12,000 gal. per hr. continuous treatment of 24 hr.; chemical mixing tank; sludge arrangements; sand filter section; "Permutit" section.

TASTE AND ODOR REMOVAL. Combating Tastes in West Virginia Water Supplies in 1930, E. S. Tisdale. *Am. Water Works Assn.—Journal*, vol. 23, no. 9, Sept. 1931, pp. 1357–1365. Experience of various sections of the state during the drought of 1930; odors, tastes, high chlorine demand, and dangers of excessive loadings on filter plants.

WATER WORKS ENGINEERING

WATER WORKS, ANCIENT. An Artificial Subterranean Water Supply System, L. W. Parr. *Am. Water Works Assn.—Journal*, vol. 23, no. 7, July 1931, pp. 1014–1016, 1 fig. Notes on ancient underground water supply systems for Syrian towns situated along edge of desert.

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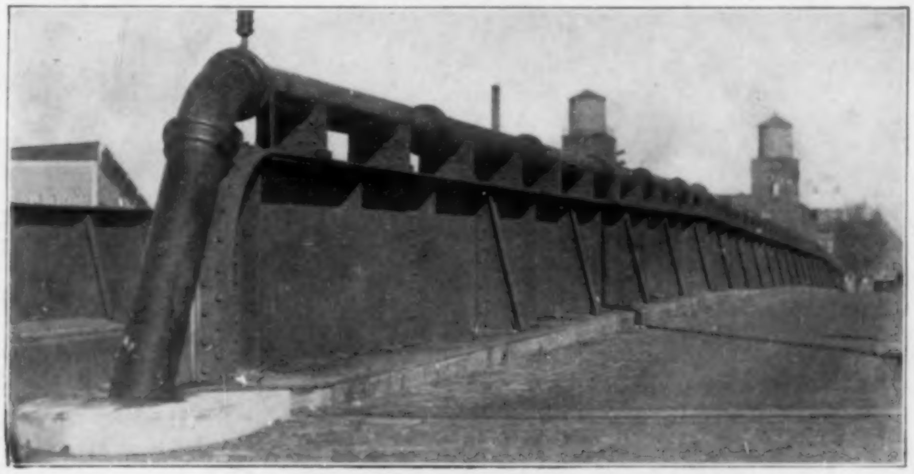

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